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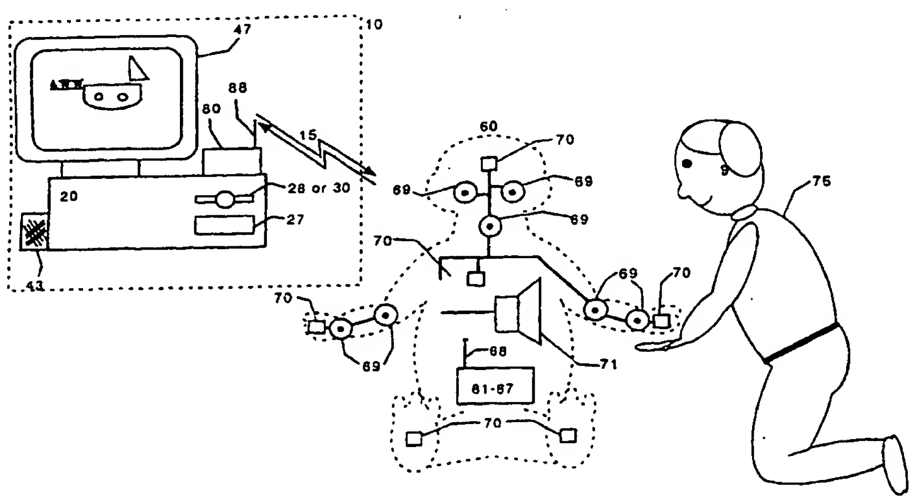

(57) Abstract

A method and system for encoding control data into the horizontal overscan area of a video signal. Because the control data is concatenated with the video signal on a line–by–line basis, the control data is temporarily synchronized with the underlying video signal. This permits the controlled devices, such as wireless mechanical characters, behave as characters in a scene defined by the programming information of the video signal. A protocol is defined for the encoded data that is addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product. The bandwidth of the communication link defined by the encoded data is adjustable to meet the cost and performance needs of a wide variety of consumers. Sufficient bandwidth is available to control several devices and to provide additional advertising, subscription, or emergency warning services, such as e–mail, foreign language subtitling, intercom capability, telephone pages, weather warnings, configuration data for a set–top box, and so forth.

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METHOD AND SYSTEM FOR ENCODING DATA IN THE HORIZONTAL OVERSCAN PORTION OF A VIDEO SIGNAL

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Application Serial No. 08/795,710 entitled "PROTOCOL FOR A WIRELESS CONTROL SYSTEM" filed on February 4, 1997, which is assigned to a common assignee.

TECHNICAL FIELD

The present invention relates to wireless communication systems and, more particularly, relates to encoding data in the horizontal overscan portion of a video signal.

BACKGROUND OF THE INVENTION

A variety of consumer products available today rely upon the use of wireless communication. Examples include cordless phones, garage door openers, remotely controlled appliances, and remotely controlled toys. A common motivation that drives manufacturers of these and similar products is minimizing the cost associated with providing the wireless communication capability. Thus, techniques for minimizing the cost of radio equipment for

transmitting and receiving radio frequency signals while maintaining reliable communication are continuously explored.

Interactive toys, games, and learning products for the home could be particularly useful applications of wireless communication technology. Wireless systems eliminate the use of wire-line communication links and, therefore, are preferable for many household applications. For example, wireless toys, games, and learning products eliminate wires that small children might tangle or pull free, or that dogs might chew. Wireless products also avoid the need for universal plugs or adapters and allow a large number of wireless devices to be controlled by a single controller without requiring a large terminal port for plugging-in the controlled devices. Wireless communication links are therefore safer, more robust, more versatile, and in many cases less expensive than wire-line communication links.

There are a number of often competing objectives in designing wireless products, such as toys, games, and learning products, for use in a home environment. First, the entire system should be priced within an acceptable range for a children's entertainment product. Furthermore, because each child may desire new controlled devices over time, the cost of each controlled device should be as low as possible. This means that the controlled devices should include inexpensive wireless communication equipment, such as conventional amplitude modulation (AM) radio equipment and digital data handling equipment.

Second, it is advantageous for several wireless devices to be controlled simultaneously by a single controller. In the context of a wireless toy environment, this allows several children to interact with their own toys at the same time. For example, one child may interact with a "FRED" toy, while another interacts with a "WILMA" toy, while yet another interacts with a "DINO" toy, etc. In addition, it is advantageous for a variety of different toys to be available so that children have a selection of toys to choose from and

collect. Moreover, in a progressive learning system, it is advantageous to have a series of toys associated with different skills so that a child can progress through the skills learned by interacting with the different toys.

Third, it is advantageous for the controller and the controlled devices to be operable for engaging in bidirectional communications. This is particularly useful in an interactive learning environment in which a child interacts with a controlled device. For example, the controller may direct a controlled doll to say, "Please squeeze my left hand." The controlled doll may then transmit the child's response back to the controller, which responds accordingly. For example, if the child squeezes the doll's right hand, the controller directs the doll to say, "No that's my right hand, please squeeze my left hand."

A fourth consideration is forward compatibility. This means that the original controller can be used to operate future versions of controlled devices. For example, an interactive toy product may initially be introduced with only one or two controlled devices (e.g., "FRED" and "WILMA"). But over the next several years, dozens of new controlled products may be released to upgrade the system (e.g., "DINO," "BAM-BAM," etc.). Forward compatibility allows the new controlled devices to be operated by the original controller.

In addition, control data must be provided to the controller, which in turn transmits the control data to the controlled devices through a local wireless communication link. Although the control data may be generated locally, for example by a computer located in close proximity to the controller, it is also desirable to transmit the control data from a remote location using a broadcast-level communication link, such as an air-wave or cable television signal. In particular, it would be advantageous to broadcast the control data along with a standard video signal for driving a display device, such as a television or monitor. In this manner, the controlled devices may be caused to operate in synchronism with the programming information defined by the video signal.

For example, a controlled device may operate as a character in a video program displayed on the television or monitor.

In order to effectively broadcast the control data in connection with a video signal, several often competing objectives should be attained. First, as noted above, the control data should be temporarily synchronized with the video signal so that the actions of the controlled devices operate in synchronism with the programming information displayed on the television or monitor. Second, the control data should be easily concatenated with a standard video signal for transmission in a variety of broadcast media using standard equipment. Third, the control data should not interfere with the video signal or visibly disrupt the display of the video signal. Fourth, sufficient bandwidth should be provided in the upstream communication link (e.g., a broadcast-level communication link) to fully satisfy the bandwidth requirements of the downstream communication link (e.g., local wireless communication link). In addition, it would be advantageous for additional bandwidth to be available in the upstream communication link for transmitting additional information for other data sinks to provide advertising, subscription, or emergency warning services, such as e-mail, foreign language subtitling, telephone pages, weather warnings, configuration data for a set-top box, and so forth. It would also be advantageous for the bandwidth of the upstream communication link to be adjustable to meet the cost and performance needs of a wide variety of consumers.

As with the downstream wireless communication link, the protocol for the upstream communication link should be addressable so that several wireless controlled devices, as well as other data sinks, may be controlled simultaneously. The protocol should also be error tolerant and accommodate forward compatibility for future wireless controlled devices and other services that may be provided through the broadcast media. All of these attributes

should be implemented at a cost that is feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product.

There is, therefore, a need for a method and system for encoding control data for wireless controlled devices in connection with a video signal so that the actions of the controlled devices operate in synchronism with the programming information defined by the video signal. There is a further need for a method and system for encoding additional data in connection with the video signal for providing services, such as e-mail, intercom capability, foreign language subtitling, telephone pages, weather warnings, configuration data for a set-top box, and so forth. There is a further need for a protocol for encoding data in connection with a video signal that is be addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product.

SUMMARY OF THE INVENTION

The present invention meets the needs described above by providing a method and system for encoding control data in the horizontal overscan portion of a video signal. Because the control data is concatenated with the video signal on a line-by-line basis, the control data is temporarily synchronized with the underlying video signal. This permits the controlled devices, such as wireless mechanical characters, to behave as characters in a scene defined by the programming information of the video signal. A protocol is defined for the encoded data that is addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product. The bandwidth of the communication link defined by the encoded data is adjustable to meet the cost and performance needs of a wide variety of consumers. Sufficient bandwidth is available to control several devices and to provide additional advertising, subscription, or emergency warning services, such as e-mail, foreign language subtitling,

intercom capability, telephone pages, weather warnings, configuration data for a set-top box, and so forth.

Generally described, the invention provides a method for encoding control data in a video signal that includes a series of frames that each include a number of lines. The encoded data is concatenated with the lines of the video signal to create an encoded video signal, which is configured to define content data in association with each frame. The content data is configured to define a first address associated with a first device, device-specific control data for the first device, a second address associated with a second device, and device-specific control data for the second device. In response to the first address, the device-specific control data for the first device is routed to the first device and the actions of the first device are controlled accordingly. Similarly, in response to the second address, the device-specific control data for the second device is routed to the second device and the actions the second device are controlled accordingly.

The video signal typically defines programming information including a scene displayed on a display device. The device-specific control data for the first device typically includes voice and motor control data that causes the first device to behave as a character in the scene displayed on the display device. The device-specific control data for the second device may be voice or motor control data that causes the second device to behave as a second character in the scene displayed on the display device, electronic mail for a transmission to a computer system, intercom information for transmission to an intercom system, telephone paging information for transmission to a paging system, or language translation information, advertising information, subscription information, or emergency warning information displayed on the display device. Many other specific applications will be apparent to those skilled in the art.

The addressing scheme for the device-specific control data implements a versatile and extensible packet-based data transmission format. For example,

the first address may be a first start-packet short address word for a first controlled device, and the second address may be a second start-packet short address word for a second controlled device. In this case, the second start-packet short address word may be interpreted as an end-packet short address word for the first controlled device.

In addition, the first address may define a start-packet begin-long-address word. In this case, the content data also defines a first occurrence of a long address associated with the first device, and a start-packet end-long-address word associated with the first device, device-specific control data for the first device.

According to an aspect of the invention, the encoded data may include signal detection words and content words. Each signal detection word and each content word may include data bits and error correction bits that are used to correct errors in the data bits. Specifically, the error correction bits may define a correction sequence that allows a single-bit error in the data bits to be detected and corrected. Each signal detection word may include four data bits and three error correction bits, and each content word may include nine data bits and seven error correction bits.

According to another aspect of the invention, a signal detection word may be encoded into each frame of the video signal such that a consecutive series of the signal detection words defines a dynamic validation sequence. For this sequence, each signal detection word varies in at least two bits from the immediately preceding signal detection word. For example, the dynamic validation sequence transmitted in consecutive fields of a two-field interlaced frame of the video signal may include the binary representation of 8, 1, 10, 3, 12, 5, 14, 7.

According to yet another aspect of the invention, the encoded data is defined by line signals located in the horizontal overscan portion of a video signal. Specifically, each line signal may be a pre-visible pulse located between

the color burst portion and the visible raster portion of a horizontal scan line of the video signal. Each pulse may define a single bit of the encoded data, in which case the encoded data of each field of a two-field interlaced frame of the video signal may define one 7-bit signal detection word and 13 16-bit content words. To increase the bandwidth of the encoded data transmission, each line signal may include both a pre-visible pulse and a post-visible pulse located after the visible raster portion and before the horizontal blanking interval. To further increase the bandwidth of the encoded data transmission, each pulse may be modulated to define several bits.

The invention also provides an encoded video signal, which is created according to the method described above, and a system for creating and using the encoded video signal. The system includes a video data encoder that is functionally connected to a video source that provides a video signal, such as an NTSC television signal. The video data encoder receives the video signal, which includes a series of frames that each include a number of lines. The video data encoder concatenates encoded data with the lines of the video signal to create the encoded video signal.

The video data encoder is functionally connected to data decoder that receives the encoded video signal from the video data encoder. The data decoder detects the presence of the signal detection data, extracts the content data from the encoded video signal, and assembles the content data into a serial data communication signal. The data decoder is functionally connected to a data error processor that receives the serial data communication signal from the data decoder. The data error processor parses the serial data communication signal into data bits and error corrections bits, analyzes the error correction bits to detect errors in the data bits, corrects detected errors in the data bits, and assembles the corrected data bits into an error corrected data stream.

The data error processor is functionally connected to a protocol handler that receives the error corrected data stream from the data error processor.

The protocol handler detects a first start-packet short address word associated with a first device and, in response, begins the routing of subsequently received device-specific control data to the first device. The protocol handler also detects a second start-packet short address word associated with the second device and, in response, begins the routing of subsequently received device-specific control data to the second device. The protocol handler also interprets the second start-packet short address word as a first end-packet short address word associated with the first device and, in response, discontinues the routing of subsequently received device-specific control data to the first device.

The protocol handler also detects a start-packet start-long-address word, detects a long address associated with a third device, detects a start-packet end-long-address word, and begins the routing of subsequently received device-specific control data to the third device. To end the transmission to the third device, the protocol handler detects a further address word and, in response, discontinues the routing of subsequently received device-specific control data to the third device.

That the invention improves over the drawbacks of the prior art and accomplishes these advantages will become apparent from the following detailed description of the exemplary embodiments and the appended drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a duplex wireless control environment including a controller and a controlled device.

FIG. 2 is a block diagram of the personal computer that forms a part of the controller of FIG. 1.

FIG. 3 is a block diagram of a wireless modem that forms a part of the controller of FIG. 1.

FIG. 4 is a block diagram of a simplex wireless control environment including a controller and a controlled device.

FIG. 5 is a block diagram illustrating a system for creating a data stream including video data and encoded control data.

FIG. 6 is a block diagram illustrating the various components and processes that define a wireless modem that forms a part of the controller of FIG. 4.

FIG. 7 is a functional block diagram illustrating the various components and processes that define the controlled device of FIG. 4.

FIG. 8 is a functional block diagram of a system for creating and using an encoded video signal to control a plurality of data sinks.

FIG. 9A is a wave form diagram illustrating a data bit value "one" encoded in the horizontal overscan portion of a scan line of an encoded video signal.

FIG. 9B is a wave form diagram illustrating a data bit value "zero" encoded in the horizontal overscan portion of a scan line of an encoded video signal.

FIG. 10A is a diagram illustrating the location of data bits in a portion of a frame of an encoded video signal.

FIG. 10B is a diagram illustrating the location of data bits in two interlaced fields of a frame of an encoded video signal.

FIG. 11 is a message protocol diagram illustrating the format of the horizontal overscan data stream of an encoded video signal.

FIG. 12A is a message protocol diagram illustrating the format of short address content data of an encoded video signal.

FIG. 12B is a message protocol diagram illustrating the format of long address content data of an encoded video signal.

FIG. 13 is a logic flow diagram illustrating the operation of a video data detector in a system for creating and using an encoded video signal to control a plurality of data sinks.

FIG. 14 is a logic flow diagram illustrating the operation of a data error detector in a system for creating and using an encoded video signal to control a plurality of data sinks.

FIG. 15 is a logic flow diagram illustrating the operation of a protocol handler for short addresses in a system for creating and using an encoded video signal to control a plurality of data sinks.

FIG. 16 is a logic flow diagram illustrating the processing of short addresses in the protocol handler of FIG. 15.

FIG. 17 is a logic flow diagram illustrating the operation of a protocol handler for long addresses in a system for creating and using an encoded video signal to control a plurality of data sinks.

FIG. 18 is a logic flow diagram illustrating the processing of long addresses in the protocol handler of FIG. 17.

DETAILED DESCRIPTION

An exemplary embodiment of the invention is a system for encoding control data into the horizontal overscan area of a video signal. Because the control data is concatenated with the video signal on a line-by-line basis, the control data is temporarily synchronized with the underlying video signal. This permits the controlled devices, such as wireless mechanical characters, behave as characters in a scene defined by the programming information of the video signal. The protocol for the encoded control data is addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product. The bandwidth of the communication link defined by the encoded data is adjustable to meet the cost and performance needs of a wide variety of consumers.

Sufficient bandwidth is available to control several mechanical characters and to provide additional advertising, subscription, or emergency warning services, such as e-mail, foreign language subtitling, telephone pages, intercom capability, weather warnings, configuration data for a set-top box, and so forth.

Exemplary Embodiment: The "REALMATION" System

The present invention may be deployed in a wireless communication environment that includes a controller (also referred to as a master device) that communicates with and controls one or more controlled devices (also referred to as slave devices) on a single radio-frequency (RF) communication channel. A specific embodiment of the invention is known as the "REALMATION" system. "REALMATION," derived from combining the words "realistic" and "animation," is descriptive of a new technology developed by Microsoft Corporation of Redmond Washington. A controller in a typical "REALMATION" system includes a computer system with a display device and a wireless modem that communicates with and controls one or more controlled devices, such as animated mechanical characters. The controller drives a display device to depict programming information, such as scenes of an audio/video presentation, while simultaneously transmitting control data, including voice coefficients and motion vectors, to one or more mechanical characters. The mechanical characters, in response to receiving the control data, move and talk as characters in the scenes depicted on the display device.

Microsoft Corporation is developing a "REALMATION" product line that includes two main components: a controller (i.e., master device) known as the "REALMATION CONTROLLER," and one or more controlled devices (i.e., slave devices) known as "REALMATION PERFORMERS." A controlled device may be specially designed for a specific industrial, educational, research, entertainment, or other purpose. For example, a controlled device such as the "BARNEY" dinosaur character is specially designed for a learning and

entertainment system for small children. Each controlled device includes an RF receiver system for receiving, demodulating, and decoding signals transmitted by the controller. The signals transmitted by the controller contain control data, such as speech coefficients and motion vectors. The control data causes the controlled device to behave as a character in a scene depicted on a display device driven by the controller.

In a duplex environment, each controlled device may also include an RF transmitter system for encoding, modulating, and transmitting response signals back to the controller. These response signals may include test or receptor data defining status information concerning the controlled device. For example, a controlled device may include pressure or light sensitive receptors for receiving user input, such as squeezing or covering a part of the character. This is particularly useful in an interactive learning environment in which a child interacts with the controlled device. For example, the controller may direct a "BARNEY" controlled device to say, "Please squeeze my left hand." The controlled device may then transmit the child's response back to the controller, which responds accordingly. For example, if the child squeezes the controlled device's right hand, the controller may direct the controlled device to say, "No, that's my right hand, please squeeze my left hand."

The controller includes a data source that receives or generates video data and related control data so that one or more controlled devices may behave as characters in a scene depicted on a display device. To do so, the control system includes a wireless modem (or wireless modulator for a simplex environment), known as the "REALMATION LINK MASTER," and a display device, such as a television or a computer monitor. The data source may be an active device, such as computer system or an interactive television system, that generates the video data and related control data in real-time. Alternatively, the data source may be a passive device, such as a cable system, VCR, or television broadcast signal, that feeds a previously-created data stream including

video data and encoded control data to the wireless modem. In this case, the wireless modem extracts the control data from the data stream, feeds the video data to the display device, and broadcasts the control data to one or more controlled devices.

In addition, the controller may be an intelligent system that is operative to generate, select, and combine video and control data from a number of sources in response to user input or other control signals. Regardless of the configuration, some type of data source provides a data stream including video and related control data, and the wireless modem extracts the control data from the video data, routes the video data to the display device, and broadcasts the control data to one or more controlled devices. To broadcast control data, the wireless modem encodes the control data into a special differential-pulse data modulation (DDM) format and transmits the DDM-encoded control data to the controlled devices. In addition, the wireless modem may receive DDM-encoded response signals from the controlled devices and decode the response signals.

The "REALMATION" product line may operate in a simplex environment or in a duplex environment. The operation of exemplary embodiments of the controller, the wireless modem (or modulator), and the controlled devices in these environments will be described in the context of programs running on microprocessor-based computer systems. Those skilled in the art will recognize that implementations of the present invention may include various types of program modules, use various programming languages, and be operable with various types of computing equipment. Additionally, although the descriptions of exemplary embodiments describe the controller as communicating with a controlled device over an RF communication channel, those skilled in the art will appreciate that substitutions to the RF communication channel can include other communication mediums such as fiber optic links, copper wires, infrared signals, etc.

Generally, a program, as defined herein, includes routines, subroutines, program modules, components, data structures, etc., that perform particular tasks or implement particular abstract data types. Moreover, those skilled in the art will appreciate that aspects of the present invention are applicable to other computer system configurations. These other computer system configurations include but are not limited to hand-held devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, mainframe computers, and the like. Aspects of the present invention are also applicable within the context of a distributed computing environment, such as the Internet, in which tasks may be performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote memory storage devices.

In both the simplex and duplex environments, the controlled devices may be low-cost, animated, mechanical characters intended for use in an interactive learning and entertainment environment for children. At minimum, each controlled device includes a receiver system, a speech synthesizer, a speaker, a processor, and one or more servo motors. But a controlled device may include many other types of end effectors, such as light sources, heat source, inflatable devices, pumps, and so forth. Indeed, the protocol for the wireless control system is designed to be forwardly compatible with a wide range of controlled devices that may be developed in the future. In response to the receiver system receiving control data on a predefined RF channel, the processor decodes, interprets, and responds in a manner dictated by the contents of the control data. The response of the processor may include actuating one or more servo motors, providing input to the speech synthesizer, or activating any of the other end effectors provided in a particular controlled device.

In the duplex environment, the controlled devices may also include one or more sensor devices and a transmitter system. The sensor devices typically

detect actions such as a child squeezing the hand, covering the eyes, or changing the position of the controlled device. By monitoring output signals from the sensors, the processor collects status information. Upon receiving a request from the controller, the processor transmits this sensor status information to the controller. In response to receiving the sensor status information, the controller may alter the animated audio/video presentation in a manner commensurate with the information. For example, in response to the action of a child covering the eyes of the controlled device, the audio/video presentation may switch to a game of peek-a-boo.

Thus, in the duplex environment, the controller engages in bidirectional communication with one or more controlled devices. Although the description of the duplex environment of the controller describes a program running on a personal computer and cooperating with another program running on a microprocessor-based communication device, those skilled in the art will recognize that other implementations, such as a single program running on a stand-alone platform, a distributed computing device equipped with radio communication equipment, or an interactive television system, may also suffice.

In the simplex environment, the controller engages in unidirectional communication with one or more controlled device. Although the description of the simplex environment of the controller describes a video cassette recorder (VCR) or a cable television box interfacing with a program running on a microprocessor-based communication device, those skilled in the art will recognize that other implementations, such as direct broadcasting signals, laser disc players, video tape players, computing devices accessing CD-ROM's, etc., may also suffice. In addition, the simplex environment may include integrating a VCR or similar device with a microprocessor-based communication device for operating in a stand-alone configuration.

The detailed description that follows is represented largely in terms of processes and symbolic representations of operations by conventional computer

components, including a microprocessor unit (MPU), memory storage devices for the MPU, display devices, output control signals, and input devices. Furthermore, these processes and operations may utilize conventional computer components in a heterogeneous distributed computing environment, including remote file servers, remote computer servers, and remote memory storage devices. Each of these conventional distributed computing components is accessible by the MPU through a communications network.

The processes and operations performed by the computer include the manipulation of signals by a MPU or remote server and the maintenance of these signals within data structures resident in one or more of the local or remote memory storage devices. Such data structures impose a physical organization upon the collection of data stored within a memory storage device and represent specific electrical or magnetic elements. These symbolic representations are the means used by those skilled in the art of computer programming and computer construction to most effectively convey teachings and discoveries to others skilled in the art.

For the purposes of this discussion, a process is generally conceived to be a sequence of computer-executed steps leading to a desired result. These steps generally require physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, compared, or otherwise manipulated. It is conventional for those skilled in the art to refer to these signals as bits, bytes, words, data, flags, variables, parameters, objects, properties, tags, types, identifiers, values, elements, symbols, characters, terms, numbers, points, records, images, files, or the like. It should be kept in mind, however, that these and similar terms are associated with appropriate physical quantities for computer operations, and that these terms are merely conventional labels applied to physical quantities that exist within and during operation of the computer.

It should also be understood that manipulations within the computer are often referred to in terms such as adding, comparing, receiving, sending, transmitting, replying, etc., which are often associated with manual operations performed by a human operator. The operations described herein are machine operations performed in conjunction with various inputs provided by a human operator or user that interacts with the computer.

In addition, those skilled in the art will understand that the programs, processes, methods, etc., described herein are not related or limited to any particular computer or apparatus, nor are they related or limited to any particular communication network architecture. Rather, various types of general purpose machines may be used with program modules constructed in accordance with the teachings described herein. Similarly, it may prove advantageous to construct a specialized apparatus to perform the method steps described herein. The specialized apparatus could consist of dedicated computer systems in a specific network architecture with hard-wired logic or programs stored in nonvolatile memory, such as read only memory, magnetic storage devices, or optical storage devices.

The communication between the master and slave devices will be described in the context of RF signal transmissions formed in accordance with amplitude modulation (AM) techniques. The RF signals are used to transfer symbolic representations of digital information from one device to another. The RF signals are generated by modulating the amplitude of a carrier signal in a predetermined manner based on the value of a symbolic representation of the digital data. Those skilled in the art will understand that a variety of communication technologies may be utilized for transmitting the information between these devices and that describing the use of AM techniques should not restrict the principles of any aspect of the present invention.

Referring now to the drawings, in which like numerals represent like elements throughout the several figures, aspects of the present invention and

exemplary operating environments will be described. Reference is made to FIGS. 1-7 below to provide a description of suitable environments in which the invention may be implemented. Reference is then made to FIGS. 8-14 to describe the preferred wireless communication protocol for controllers and controlled devices in these environments.

Duplex Environment

FIG. 1 illustrates an exemplary duplex environment for embodiments of the present invention. This duplex environment may be operated as an interactive learning and entertainment system for a child. The duplex environment includes a controller **10** that controls and interacts with a controlled device **60**. The controller **10** includes a conventional personal computer **20**, a wireless modem **80**, an antenna **88**, a speaker **43**, and a display device **47**. The personal computer **20** may include a hard disk drive **27**, a magnetic disk drive **28**, and/or an optical disk drive **30**.

During operation, the controller **10** drives an audio/video presentation on the display device **47** and the speaker **43**. In addition, the controller **10** transmits message packets that may include control data to the controlled device **60**. The control data typically includes voice synthesis coefficients and motor vectors for controlling the operation of the controlled device **60**. The process of transmitting the control data includes building a data stream using the proper protocol, modulating a carrier with the data stream, and emitting the modulated carrier as an RF signal from the antenna **88** over the RF communication channel **15**. More specifically, the controller **10** includes a multimedia personal computer system **20** and a wireless modem **80**. The computer system **20** passes the control data to the wireless modem **80** through a wired connection between the wireless modem **80** and the game (MIDI) port of the computer system **20**. The wireless modem **80** then builds the data stream using

the proper protocol, modulates a carrier with the data stream, and emits the modulated carrier over the RF communication channel **15**.

The controlled device **60** receives the RF signals from the controller at the antenna **68**. The receiver system **61-67** processes the received RF signals to recover the control data. The controlled device **60** interprets the received control data and responds to the control data by controlling the operation of one or more servo motors **69** or other end effectors within the controlled device **60**, which includes providing speech data to be audibly presented by the speaker **71**. Thus, transmitting the appropriate control data to the controlled device **60** causes the controlled device **60** to move and talk as though it is a character in the audio/video presentation.

The controlled device **60** also includes light sensors and touch sensors **70**. In response to a child touching, squeezing, or moving the controlled device **60** in an appropriate manner, the light sensors and/or touch sensors **70** within the controlled device **60** generate status information. In response to a command from the controller **10**, the controlled device **60** transmits the status information over the RF communication channel **15** back to the wireless modem **80** for processing by the controller **10**. In response to receiving and interpreting the status information, the controller **10** may alter the progression of the audio/video presentation in a manner commensurate with the status information.

FIG. 2 illustrates an exemplary computer system for implementing the controller **10** in the duplex environment illustrated in FIG. 1. The exemplary computer system includes a conventional personal computer **20**, including a processor **21**, a system memory **22**, and a system bus **23** that couples the system memory to the processor **21**. The system memory **22** includes a read only memory (ROM) **24** and a random access memory (RAM) **25**. The ROM **24** provides storage for a basic input/output system **26** (BIOS), containing the basic routines that help to transfer information between elements within the

personal computer **20**, such as during start-up. The personal computer **20** further includes a hard disk drive **27**, a magnetic disk drive **28** for reading from or writing to a removable disk **29**, and an optical disk drive **30** for reading a CD-ROM disk **31** or for reading from or writing to other optical media. The hard disk drive **27**, the magnetic disk drive **28**, and the optical disk drive **30** interface to the system bus **23** through a hard disk drive interface **32**, a magnetic disk drive interface **33**, and an optical drive interface **34**, respectively. The drives and their associated computer-readable media provide nonvolatile storage for the personal computer **20**. Although the description of computer-readable media above refers to a hard disk, a removable magnetic disk, and a CD-ROM disk, those skilled in the art will understand that other types of media that are readable by a computer, such as magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, and the like, may also be used in the exemplary operating environment.

A number of program modules may be stored in the drives **27-30** and RAM **25**, including an operating system **35**, one or more application programs **36**, other program modules **37**, and program data **38**. A user may enter commands and information into the personal computer **20** through a keyboard **40** and pointing device, such as a mouse **42**. Other input devices (not shown) may include a microphone, a joystick, a track ball, a light pen, a game pad, a scanner, a camera, or the like. These and other input devices are often connected to the processor **21** through a serial port interface **46** that is coupled to the system bus, but may be connected by other interfaces, such as a game port or a universal serial bus (USB). A computer monitor **47** or other type of display device is also connected to the system bus **23** via an interface, such as a video adapter **48**. One or more speakers **43** are connected to the system bus via an interface, such as an audio adapter **44**. In addition to the monitor and speakers, personal computers typically include other peripheral output devices (not shown), such a printers and plotters.

The personal computer **20** may operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **49**. Although only a memory storage device **50** has been illustrated in FIG. 2, the remote computer **49** may be a server, a router, a peer device, or other common network node, and typically includes many or all of the elements described relative to the personal computer **20**. The logical connections depicted in FIG. 2 include a local area network (LAN) **51** and a wide area network (WAN) **52**. These types of networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and the Internet.

When used in a LAN networking environment, the personal computer **20** is connected to the LAN **51** through a network interface **53**. When used in a WAN networking environment, the personal computer **20** typically includes a modem **54** or other means for establishing communications over the WAN **52**, such as the Internet. The modem **54**, which may be internal or external, is connected to the system bus **23** via the serial port interface **46**. In a networked environment, program modules that may be accessed by the personal computer **20**, or portions thereof, may be stored in the remote memory storage device. The network connections shown are exemplary and other means of establishing communications links among the computers may be used.

The personal computer **20** contains a musical instrument digital interface (MIDI) adapter **39**, which allows the MPU **21** to control a variety of MIDI compatible devices (e.g., electronic keyboards, synthesizers, etc.) The MIDI adapter may also allow the MPU **21** to control a wireless modem **80**. The MIDI adapter operates by receiving data over the system bus **23**, formatting the data in accordance with the MIDI protocol, and transmitting the data over a MIDI bus **45**. The equipment attached to the MIDI bus detects the transmission of the MIDI formatted data and determines whether the data is to be accepted and processed or ignored. That is, the wireless modem **80** examines the data

on the MIDI bus and only processes data that explicitly identifies the wireless modem **80** as the intended recipient. In response to receiving data, the wireless modem **80** may transmit the data, such as control data intended for one or more controlled devices, over the RF communication channel **15**.

FIG. 3 is a block diagram illustrating the various components that define the wireless modem **80**. Initially, a program running on the computer **20** obtains control data by generating the data or retrieving the data from a storage media accessible to the computer **20**. In addition, the program may format the control data in accordance with a predefined protocol, such as a specific "REALMATION" protocol. Or in the alternative, the program may retrieve preformatted control data from a storage media. The program transfers the control data to the wireless modem **80** over the MIDI interface including the MIDI adapters **39** and **81** and the MIDI bus **45**. This process includes repackaging the control data into the MIDI format. Those skilled in the art will appreciate that the MIDI interface is only one of several possible interfaces that can be used to transfer control data between the computer **20** and the wireless modem **80**. Alternative interfaces include, but are not limited to, interfaces such as RS232, Centronix, and SCSI.

The protocol handler **83** receives the MIDI formatted data from the MIDI adapter **81** and removes the MIDI formatting to recover the control data. During this process, the protocol handler **83** may temporarily store the control data and or the MIDI formatted data in the data buffer **82**. The protocol handler **83** may also perform other manipulations on the control data in preparation for transmitting the data. Before transmitting the control data, the data encoder **84** encodes the control data and provides the encoded control data to the RF transmitter **86**. The RF transmitter uses the encoded control data to modulate a carrier and then transmits the modulated carrier over the RF communications channel **15** from the antenna **88**.

The wireless modem **80** may also receive signals carrying response data originating from one or more controlled devices **60** or other devices. The wireless modem **80** detects these signals at the antenna **88** and provides the signals to the RF receiver **87**. The RF receiver **87** demodulates the received signals, recovers the encoded response data, and provides the encoded response data to the data decoder **85**. The data decoder **85** decodes the encoded response data and provides the decoded response data to the protocol handler **83**. The protocol handler **83** formats the decoded response data into the MIDI format and transfers the MIDI formatted data to the computer **20** through the MIDI interface **81**. The protocol handler **83** and or the MIDI interface **81** may temporarily store the response data in the data buffer **82** during processing. Upon receiving the information at the MIDI Interface **39**, the computer **20** recovers the response data from the MIDI formatted data and then processes the response data.

Simplex Environment

FIG. 4 illustrates an exemplary simplex environment for embodiments of the present invention. This simplex environment may be operated as a learning and entertainment system for a child. The simplex environment includes a controller **11** that controls a controlled device **60**. The controller **11** includes an audio/video signal source **56**, a wireless modulator **90**, an antenna **98**, and a display device **57** including a speaker **59**. The controller **11** transmits control data to the controlled device **60** via an antenna **98** and an RF communication channel **15**. To accomplish this task, the wireless modulator **90** interfaces with the audio/video signal source **56** and the display device **57** through a standard video interface. Over this standard video interface, the wireless modulator **90** receives a video signal encoded with control data (encoded video) from the audio/video signal source **56**. The wireless modulator **90** extracts the control

data from the encoded video signal, and then transfers the control data to a controlled device **60** through the RF communication channel **15**.

In addition, the wireless modulator **90** passes the video signal to the display device **57**. The audio/video signal source **56** also interfaces with the speaker **59** in the display device **57**. Over this interface, the audio/video signal source **56** provides audio for an audio/video presentation. Thus, a child can observe the audio/video presentation on the display device **57** and the speaker **59** while the wireless modulator **90** transmits control data to one or more controlled device **60**. The reception of the control data causes the controlled device **60** to move and talk as though it is a character in the audio/video presentation.

There is no need to modify the encoded video signal before passing it to the display device **57**. Typically, the controller **11** receives the encoded video signal, which is a standard video signal that has been modified to include digital information in the horizontal overscan intervals of the scan lines, which are invisible to the display device **57**. Thus, the display device **57** can receive and display the encoded video signal without modification. The controller **11** only needs to extract the control data from the encoded video signal and generate the RF-modulated control signals for transmission to the controlled device **60**.

FIG. 5 is a block diagram illustrating a system for creating an encoded video data stream including video data and encoded control data. A variety of sources, including but not limited to, a video cassette recorder or player, a cable reception box, a TV tuner, a laser disc player, or a computer with a video output, may provide the encoded video. In FIG. 5, the computer system **20** interfaces with a video data encoder **76** and an audio/video signal source **56**. The audio/video signal source **56** provides two output signals: video and audio. These output signals may include live camera feeds, prerecorded playbacks, broadcast reception, etc. The computer system **20** controls the operation of the

audio/video source **56** via a control signal. The control signal gates the output of the video and audio signals from the audio/video signal source **56**.

The computer system **20** also provides the control data, which is encoded onto the video signal. The computer system **20** transfers the control data and gates the video signal to the video data encoder **76**. The video data encoder combines the video signal and the control data by encoding the control data onto the video signal (i.e., generating an encoded video data stream). This encoding technique includes modulating the luminance of the horizontal overscan area of the video signal on a line-by-line basis. For example, the overscan area of each scan line may be modulated to represent a single control data bit. Furthermore, the field boundaries of the video signal provide a framing structure for the control data, in which each frame contains a fixed number of data words.

More specifically, each field of the video signal contains a pattern identification word consisting of four bits. The value of the pattern identification word in each contiguous field cyclically sequences through a defined set of values. The presence of the pattern identification word distinguishes an encoded video signal from a normal video signal. In a normal video signal, random noise appears in place of the pattern identification word. A decoder attempting to recover control data from an encoded video signal therefore determines whether the signal is an encoded video signal by detecting the presence of the pattern identification. Thus, the pattern identification word provides an additional layer of integrity to the recovered control data beyond that of simple checksum error detection.

The wireless modulator **90** receives the encoded video signal from the audio/video signal source **56** and recovers the control data from the encoded video signal. The wireless modulator **90** then transmits the control data to one or more controlled device, represented by the controlled device **60** shown in FIG. 4. Alternatively, video broadcast equipment **79** may receive the encoded

video signal along with the audio signal and then broadcast the signals to one or more remotely located wireless modulators and/or wireless modems. In another alternative, video storage equipment **78** may receive the encoded video signal along with the audio signal and then store the signals in a storage medium for future retrieval.

FIG. 6 is a block diagram illustrating the various components that define the wireless modulator **90**. Each of the components of the wireless modulator **90** may be implemented in hardware, software, or a combination of hardware and software. The video data detector **91** of the wireless modulator **90** receives a video signal, originating from an audio/video signal source **56**, and identifies whether the video signal is an encoded video signal. If the video data detector **91** detects the presence of the pattern identification word in the received video signal, then the video signal is an encoded video signal. If the signal is an encoded video signal, the video data detector **91** extracts the control data from the encoded video signal, provides the control data to the data error processor **99**, and simultaneously provides the encoded video signal to the display device **57**.

The data error processor **99** analyzes the control data to detect and attempt to correct any errors that may exist in the control data. After correcting any errors in the control data, the protocol handler **93** receives the recovered and verified control data and assembles message packets for transmission to one or more controlled devices, represented by the controlled device **60**. Upon assembling a message packet, the protocol handler **93** provides the message packet to the data encoder **94**. The data encoder **94** encodes the data and provides the encoded data to the RF transmitter **96**. The RF transmitter **96** receives the encoded data and modulates a predefined RF carrier (i.e., a predefined RF channel approved for use in connection with the wireless communication system) with the encoded data. The RF transmitter then transmits the modulated carrier through the antenna **98**. During

processing of the control data, the various components of the computer system **20** or the wireless modulator **90** may temporarily store the control data in a data buffer, such as the representative data buffer **92**.

The display device **57** receives the video signal from the video data detector **91** or another source along with an audio signal from the audio/video signal source **56**. The display device **57** and the speaker **59** then display the audio/visual presentation defined by the video signal, typically including a series of scenes depicted on the display device **57** and the speaker **59**, in a conventional manner.

As noted previously, the audio/video presentation on the display device **57** and the control data that is transmitted from antenna **98** are synchronized so that the controlled device **60** behaves as a character in the scene depicted on the display device **57**. The processes of detecting the control data, correcting any errors, encoding the control data, and then modulating a carrier may introduce a slight delay. Nevertheless, embedding the control data within the video data in the encoded video signal effectively synchronizes the operation of the controlled device with the scene depicted on the display device **57**. In other words, the video signal received by the display device **57** and the control data transmitted from antenna **98** are synchronized because they are obtained from the same area of the original encoded video signal, in which context sensitive control data is embedded within a video signal. Thus, the encoded video signal may be separated in real-time into control data and related video data so that the controlled devices move and/or talk in a manner that relates to the audio/video presentation.

Controlled Devices: "REALMATION" Performers

FIG. 7 is a functional block diagram illustrating the various components that define a controlled device **60**. Each of these components may be implemented in hardware, software, or a combination of hardware and

software. Generally, the controlled device **60** includes a microprocessor, or some other type of other processor, for retrieving a program from a ROM, or some other type of non-volatile storage media, and executing the instructions of the program. The controlled device **60** may include hardware components such as an RF radio receiver **67**, an RF transmitter **66**, an antenna **68**, a readable and writable storage memory **62**, sensors **70**, servo motors **69**, a speech synthesizer **61**, and a speaker **71**.

The RF receiver **67** receives signals from the antenna **68**. The RF receiver **67** operates on the received signal by demodulating the carrier and recovering encoded control data. Next, the data decoder **65** receives and decodes the encoded control data. The protocol handler **63** receives the decoded control data output from the decoder **65** and interprets the control data. Based on the content of the control data, the protocol handler **63** routes control data to the appropriate devices, such as data buffers and end effectors within the controlled device **60**. Thus, if the control data contains motor movement vectors, one or more of the motion servo motors **69** receives the control data, which causes them to move in accordance with the motor movement vectors. Similarly, if the control data contains voice synthesis coefficients, the speech synthesizer **61** receives the voice synthesis coefficients, converts the voice synthesis coefficients into audio signals, and then provides the audio signals to the speaker **71**. Furthermore, the voice synthesis coefficients may be temporarily stored in data buffer **62** so that the controlled device **60** generates voice sounds based on the voice synthesis coefficients while the controlled device **60** transmits response data back to the controller.

The controlled device **60** may also include light sensors and touch sensors **70**. The sensors **70** may generate status information in response to variations in pressure, light, temperature, or other parameters. The controlled device **60** may transmit this status information to the controller **10** shown in FIG. 1. This process includes formatting the status information in the protocol

handler **63**, encoding the status information in the data encoder **64**, modulating a carrier with the encoded status information in the RF transmitter **66**, and then transmitting the modulated carrier over the RF communications path **15** through the antenna **68**.

Creating and Using an Encoded Video Signal

FIG. 8 is a functional block diagram of a system **100** for creating and using an encoded video signal to control a plurality of data sinks **97a-n**. The system **100** includes an audio/video signal source **56** that provides a video signal **102** to a video data encoder **76**. The audio/video signal source **56** may be any of a variety of conventional video sources, such as a video camera, a broadcast or cable television signal, a video tape player, the Internet transmitting a video signal, a computer generating a video signal, and so forth. The video signal **102** may be any type of video signal that includes a plurality of frames that each include a plurality of scan lines. For example, the video signal **102** may be a standard 525-line, two-field interlaced NTSC television signal that includes 30 frames per second, each frame including two fields of 262.5 interlaced lines, as is well known to those skilled in the art

The video data encoder **76** concatenates encoded data with the lines of the video signal **102** to create an encoded video signal **104**, as described in detail with respect to FIGS. **9A-B** and **10A-B**. A protocol is defined for the encoded data that is addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product. This protocol is described in detail with respect to FIGS. **11** and **12A-B**.

The video data encoder **76** transmits the encoded video signal **104** to a video data detector **91**, which may be a remote device that receives the encoded video signal **104** by way of a broadcast-level transmission. Alternatively, video data detector **91** may be a local device, for example in an intercom

application. The encoded data does not interfere with the transmission of the underlying video signal **102**. Thus, the encoded video signal **104** may be transmitted using any type of video transmission media, such as a broadcast-level cable television signal, a video tape player, the Internet transmitting a video signal, a computer generating a video signal, and so forth. In addition, because the encoded data is located in the pre-visible or post-visible portions of the video signal **102**, the encoded data does not visibly interfere with the operation of typical televisions or monitors. Therefore, the encoded video signal **104** may be passed directly from the video data detector **91** to the display device **57**, which displays the underlying video signal **102** undisturbed by the encoded data.

The video data detector **91** detects the presence of the encoded data in the encoded video signal **104** by detecting the presence of an intelligent signal detection word (ISDW), as described with reference to FIGS. **10A-B** and **11**. Preferably, a single ISDW is transmitted in the same location of each field of the encoded video signal **104**, such as lines 23 - 29 in field-1 and 286 - 292 in field-2, of a standard interlaced 525-line NTSC television signal. A consecutive series of the ISDWs defines a dynamic validation sequence in which each ISDW varies in at least two bits from the immediately preceding signal detection word. For example, the dynamic validation sequence may be the binary representation of 8, 1, 10, 3, 12, 5, 14, 7.

The video data detector **91** reads the data, if any, in the specified lines, corrects the data for correctable errors that may have occurred in the ISDW bits, and detects the presence of the ISDW. In each frame, the ISDW is typically followed by a number of content words. If the video data detector **91** detects the presence of the ISDW in the encoded video signal **104**, it extracts the content words from the encoded video signal and assembles the content words into a serial data communication signal **106**. The video data detector **91**

then transmits the serial data communication signal **106** to a data error processor **99**.

The data error processor **99** strips out the error correction bits, corrects any correctable errors in the content bits, and assembles the corrected content words into a 9-bit error corrected data stream **108**. This 9-bit error corrected data stream **108** is transmitted to a protocol handler **93**, which includes a number of data handlers **89a-n** that detect and route device-specific control data to their associated data sinks **97a-n**. The addressing protocol for the content data is described with reference to FIGS. **12A-B**. Each data handler **89a-n** detects address data, including a short or long address assigned to its associated data sink **97a-n**, and responds by routing the following device-specific control data **110a-n** to its associated data sink **97a-n**. Each data handler **89a-n** may also reformat the device-specific control data into appropriately-formatted data streams for its associated data sink **97a-n**.

In particular, one of the data sinks **97a** reformats the device-specific control data into MIDI format for transmission to a wireless controlled device **60** by way of a DDM encoder **94**, a modulator **95**, and a transmitter **96**, as described previously. In addition, one particular method for operating the DDM encoder **94** is described in U.S. Application Serial No. 08/794,921 entitled "A SYSTEM AND METHOD FOR CONTROLLING A REMOTE DEVICE," inventors Leonardo Del Castillo, Damon Danielli, Scott Randall, Craig Ranta, and Harjit Singh, filed on February 4, 1997, which is owned by a common assignee and incorporated herein by reference.

FIGS. 9A and 9B show the location of the encoded data in the context of a single scan line of the encoded video signal **104**. FIG. 9A is a wave form diagram illustrating a data bit value "one" **128** encoded in the horizontal overscan portion of a scan line of the encoded video signal **104**. The scan line represents one line of one frame displayed on the display device **57**. The vertical axis represents the magnitude of the signal wave form **120** in units of

IRE and the horizontal axis represents time in micro-seconds, as is familiar to those skilled in the art. Although FIGS. 9A-B are not drawn precisely to scale, important reference points are marked in the units of their corresponding axis. The wave form **120** for the scan line begins with a horizontal synchronization pulse **122** down to -40 IRE, which is a timing signal that indicates the beginning of the scan line (i.e., time = 0) when the leading edge of the pulse passes through -20 IRE to establish the horizontal reference point "H-REF." The horizontal synchronization pulse **122** is followed by a sinusoidal color burst **124** (the approximate envelope is shown), which is used as a calibration signal for the display device **57**. The color burst **124** is followed by a wave form representing the visible raster **126** (the approximate envelope is shown), which creates and typically overlaps slightly the visible image on the display device **57**.

The wave form **120** includes a pre-visible horizontal overscan area **127**, approximately from 9.2 micro-seconds to 10.2 micro-seconds after H-REF, that occurs after the color burst **124** and before the visible raster **126**. The video data encoder **76** locates a pre-visible (i.e., before the visible raster **126**) data bit "one" **128** by driving the wave form **120** to a predetermined high value, such as 80 IRE, in the interval from 9.2 micro-seconds to 10.2 micro-seconds after H-REF. Because the pulse denoting the data bit "one" **128** occurs after the calibration interval of the color burst **124** and before the visible raster **126**, it does not interfere with the operation of the display device **57** or appear on the image displayed.

FIG. 9B is a wave form diagram illustrating a data bit value "zero" **128'** encoded in the horizontal overscan portion of a scan line of the encoded video signal **104**. The video data encoder **76** locates the pre-visible data bit "zero" **128'** by driving the wave form **120** to a predetermined low value, such as 7.5 IRE, in the interval from 9.2 micro-seconds to 10.2 micro-seconds after H-REF.

As noted above, each 16-bit content word includes nine data bits, and each frame includes 13 content words. Thus, encoding one bit per scan line produces a bandwidth for the data encoded in a typical 59.94 Hertz NTSC video signal of 7,013 Baud. This bandwidth is sufficient to provide the data sink **97a** with sufficient data to control several wireless controlled devices **60** in the manner described above. See also, the related patent application, U.S. Application Serial No. 08/795,710 entitled "PROTOCOL FOR A WIRELESS CONTROL SYSTEM" filed on February 4, 1997, which is assigned to a common assignee and incorporated herein by reference.

The 7,013 Baud one-bit-per-scan-line bandwidth of the encoded data is also sufficient to control several other data sink **97b-n** to provide additional services, such as advertising, subscription, and emergency warning information for transmission to the display device **57** and other data sinks. For example, these services might include e-mail, foreign language subtitling, intercom capability, telephone pages, weather warnings, configuration data for a set-top box, and so forth. At present, the 7,013 Baud one-bit-per-scan-line bandwidth is preferred because it provides sufficient bandwidth for the "REALMATION" system and minimizes the cost of the system components, in particular the video data encoder **76** and the video data detector **91**. The bandwidth may be increased, however, by locating a second pulse in the post-visual horizontal overscan area **130**, which occurs after the visible raster **126** and before the horizontal blanking interval **132** (during which the electron gun in the CRT of the display device **57** sweeps back from the end of the just completed scan line to the beginning of the next scan line).

And the bandwidth may be further increased by enabling each pulse **128**, **130** to represent more that just two (1,0) states. For example, for 3 states (c.f., the 1.0, 1.5, 2.0 DDM pulse widths), an analog of the "REALMATION" DDM protocol could be used. For 4 states, the pulse could represent 2 bits (e.g., 100-80 IRE = 1,1; 70-50 IRE = 1,0; 40-20 IRE = 0,0; 10 to -40 IRE = 0,1). For 8

states, the pulse could represent 3 bits; for 16 states, the pulse could represent 4 bits, and so forth. For example, if the system **100** were to employ data pulses in both the pre-visual horizontal overscan area **127** and the post-visual horizontal overscan area **130**, each data pulse having 16 states, each scan line would be able to transmit eight bits. This would increase the bandwidth from 7,013 Baud to 56,104 Baud, which might be worth the increased cost for the video data encoder **76** and the video data detector **91** for future applications.

FIGS. 10A and 10B show the location of encoded data in the context of a standard NTSC video frame. FIG. 10A is a diagram illustrating the location of data bits in a portion of a standard 525-line two-field interlaced NTSC video signal. Each frame of the video data includes a vertical blanking interval **140** (during which the electron gun in the CRT of the display device **57** sweeps back and up from the end of the just completed frame to the beginning of the next frame) followed by an active video interval **142**, which includes a number of left-to-right scan lines that sequentially paint the display device **57** from the top to the bottom of the screen. At the end of the vertical blanking interval **140**, the last two pulses are typically reserved for closed caption data **146** and vertical blanking data **148**, which may be already dedicated to other purposes. In addition, the bottom of each field is typically corrupted by head switching noise present in the output of helical-scan video tape players of consumer formats such as VHS and 8mm. Therefore, the horizontal overscan portion of individual scan lines provides the preferred location for encoded data bits **128, 128'** of the encoded video signal **104**.

FIG. 10B is a diagram illustrating the location of data bits in the two interlaced fields of the standard NTSC video frame. That is, FIG. 10B shows the location of the encoded data in the context of a complete NTSC 525-line two-field interlaced video frame. The frame of video data includes lines 1-262 in field-1 **152** interlaced with lines 263-525 in field-2 **154**. Field-1 **152** includes a vertical blanking interval **140a** and an active video interval **142a**.

The vertical blanking interval **140a** includes lines 1-22 and concludes with line 21, which may include closed caption data **146a**, and line 22, which may include vertical blanking data **148a**. An ISDW **156a** is encoded in lines 23-29 and content data **158a** is encoded in lines 30-237. Field-2 **154** includes a vertical blanking interval **140b** and a active video interval **142b**. The vertical blanking interval **140b** includes lines 263-284 and concludes with line 283, which may include closed caption data **146b**, and line 284, which may include vertical blanking data **148b**. An ISDW **156b** is encoded in lines 286-292 and content data **158b** is encoded in lines 293-500.

Each ISDW preferably includes a plurality of data bits and a plurality of error correction bits defining a correction sequence that allows a single-bit error in the data bits to be detected and corrected. For example, the ISDW may include a seven-bit Hamming code (i.e., four data bits and three error correction bits) in the format shown below in Table 1.

Video Line Number Field 1	Field 2	Symbol	Description
23	286	Q0	Sequence Word Bit 0
24	287	Q1	Sequence Word Bit 1
25	288	Q2	Sequence Word Bit 2
26	289	Q3	Sequence Word Bit 3
27	290	BO	BO = Q1 x Q2 x Q3
28	291	B1	B1 = Q0 x Q1 x Q3
29	292	B2	B2 = Q0 x Q2 x Q3

Table 1

In each field **152, 154** of a video frame, up to 13 16-bit content words **158** may follow the ISDW **156**, as shown below in Table 2.

Word Value Range Field 1	Field 2	Defined Class
30	293	Start of Content Word 0
46	309	Start of Content Word 1
62	325	Start of Content Word 2
78	341	Start of Content Word 3
94	357	Start of Content Word 4
110	373	Start of Content Word 5

126	389	Start of Content Word 6
142	405	Start of Content Word 7
158	421	Start of Content Word 8
174	437	Start of Content Word 9
190	453	Start of Content Word 10
206	469	Start of Content Word 11
222	485	Start of Content Word 12
237	500	End of Content Word 12
238-263	517-525	Unused video lines

Table 2

Each content word preferably includes a plurality of data bits **164** and a plurality of error correction bits **166** defining a correction sequence that allows a single-bit error in the data bits to be detected and corrected. For example, the content word may include a seven-bit Hamming code (i.e., four data bits and three error correction bits) and a nine-bit Hamming code (i.e., five data bits and four error correction bits) in the format shown below in Table 3.

Offset from first line	Symbol	Description
+0	M0	Data Bit 0
+1	M1	Data Bit 1
+2	M2	Data Bit 2
+3	M3	Data Bit 3
+4	B0	B0 = M1 x M2 x M3
+5	B1	B1 = M1 x M1 x M3
+6	B2	B2 = M1 x M2 x M3
+7	M4	Data Bit 4
+8	M5	Data Bit 5
+9	M6	Data Bit 6
+10	M7	Data Bit 7
+11	M8	Data Bit 8
+12	B3	B3 = M4 x M5 x M6 x M7
+13	B4	B4 = M4 x M5 x M7 x M8
+14	B5	B5 = M4 x M6 x M7 x M8
+15	B6	B6 = M5 x M6 x M7 x M8

Table 3

Although many other, often more sophisticated, data correction techniques may be used, Hamming codes are preferred because of their simplicity and small computation requirement.

FIG. 11 is a message protocol diagram illustrating the format of the horizontal overscan data stream **150** of the encoded video signal **104**. The

horizontal overscan data stream **150** is typically created by the video data detector **91**, which extracts the data from the encoded video signal **104** and assembles the extracted data into the serial data communication signal **106**. Each field of the horizontal overscan data stream **150** includes intelligent signal detection data, typically a single 7-bit ISDW, and content data, typically 13 16-bit content words. The representative ISDW **156a** includes four data bits **160** and three error correction bits **162**, as shown Table 1, above. The representative content word **158a** includes four data bits **164a**, followed by three error correction bits **166a**, followed by five data bits **164b**, followed by four error correction bits **166b**, as shown Tables 2 and 3, above.

A consecutive series of the ISDWs **155a-n** defines a dynamic validation sequence **170** in which each ISDW varies in at least two bits from the immediately preceding signal detection word. For example, the dynamic validation sequence may be the binary representation of 8, 1, 10, 3, 12, 5, 14, 7. Causing the dynamic validation sequence **170** to vary in at least two bits in each successive ISDW reduced the chance that random noise may be misinterpreted as ISDW data.

The content data includes address data **172** and device-specific control data **174**. Thus, the protocol for the content data is addressable so that device-specific control data may be directed to a number of different data sinks **97a-n**. The addressable nature of the content data is represented by the address data **172a-n** and the device-specific control data **174a-n**. To limit the bandwidth requirement of the address data **172**, a limited number of predefined short addresses are preferably reserved for assignment to data sinks. To further extend the addressability of the protocol, two short addresses are reserved for denoting the beginning and end of long addresses. This allows a virtually unlimited number of variable length long addresses to be assigned in the future.

The first data bit of each short address differentiates between address words and device-specific control words (0 = address; 1 = device-specific

control data). For an address word, the eight bits that follow the address identification bit allow up to 256 addresses. The first 254 addresses are short address classes that may be preassigned to specific classes of controlled devices. The last two addresses (0FE and 0FF) are used as start and stop delimiters for a long address. Thus, a virtually infinite number of additional class addresses of variable length may be assigned in the future using the long address delimiters. This provides the protocol with a very high degree of forward extensibility. The addressing protocol is shown below in Table 4.

Word Value Range (Binary)	(HEX)	Defined Class
0 0000 0000	000	The NULL Address
0 xxxx xxxx	001-0FD	Short Address Class
0 1111 1110	0FE	Begin Long Address Block
0 1111 1111	0FF	End Long Address Block

Table 4

FIG. 12A is a message protocol diagram illustrating the format of short address content data in the encoded video signal **104**. The content data preferably includes the error corrected content data bits assembled into a 9-bit data steam by the data error processor **99**. To address a data packet to a particular short-address data sink **97a**, that data sink's short address is transmitted in the encoded video signal **104**. The first occurrence of the data sink's short address is interpreted as a start-packet message **202a** by the data handler **89a**, which responds by beginning the routing of subsequently-received device-specific control data to the data sink **97a**. The start-packet message **202a**, therefore, is followed by device-specific control data **204a** for the selected data sink **97a**.

The packet for the data sink **97a** is ended by transmitting either the NULL address or another long or short address in the encoded video signal **104**. The new short address is interpreted as an end-packet message **206a** by

the data handler **89a**, which responds by discontinuing the routing of subsequently-received device-specific control data to the data sink **97a**. This addressing procedure may be repeated, as desired, for each data sink that is assigned a short address.

As noted above, to further extend the addressability of the protocol, two short addresses are reserved for denoting the beginning and end of long addresses. FIG. 12B is a message protocol diagram illustrating the format of long address content data in the encoded video signal **104**. To address a data packet to a particular long-address data sink **97b**, the short address dedicated to denoting a begin-long-address message **210b** (0FE) is transmitted in the encoded video signal **104**. The desired data sink's long address **212b** is then transmitted, followed by the short address dedicated to denoting an end-long-address message **214b** (0FF). The first occurrence of the data sink's long address is interpreted as a start-packet message by the data handler **89b**, which responds by beginning the routing of subsequently-received device-specific control data to the data sink **97b**. The start-packet message **202a**, therefore, is followed by device-specific control data **204a** for the data sink **97a**.

The packet for the data sink **97b** is ended by transmitting a further address word in the encoded video signal **104**. The new address is interpreted as an end-packet message by the data handler **89b**, which responds by discontinuing the routing of subsequently-received device-specific control data to the data sink **97b**. This addressing procedure may be repeated, as desired, for each data sink that is assigned a long address.

FIG. 13 is a logic flow diagram illustrating routine **1300** for the video data detector **91**. Routine **1300** begins in step **1302**, and in step **1304** the video data detector **91** receives the encoded video signal **104** from the video data encoder **76**. In step **1306**, the video data detector **91** detects a start of frame marker. In step **1308**, the video data detector **91** collects the bits in the ISDW region of the frame, and in step **1310** the video data detector **91**

corrects any correctable, typically one-bit, errors in the data. In step **1312**, the video data detector **91** determines whether the data collected from the ISDW region of the frame is, in fact, an ISDW.

Specifically, the video data detector **91** determines whether a consecutive series of the ISDWs correspond to the dynamic validation sequence **170**, in which each ISDW typically varies in at least two bits from the immediately preceding signal detection word. For example, the dynamic validation sequence may be the binary representation of 8, 1, 10, 3, 12, 5, 14, 7. If the dynamic validation sequence **170** is detected, the "YES" branch is followed from step **1312** to step **1314**, in which the video data detector **91** assembles the content words **158** into the serial data communication signal **106**. In step **1316**, the video data detector **91** detects an end of frame marker, and in step **1318** the video data detector **91** transmits the serial data communication signal **106** for the frame to the data error processor **99**. Step **1318** and the "NO" branch from step **1312** are followed by the "END" step **1320**, which returns step **1302** so that routine **1300** may repeat for the next frame of data.

FIG. 14 is a logic flow diagram illustrating routine **1400** for the data error processor **99**. Routine **1400** begins in step **1402**, and in step **1404** the data error processor **99** receives the serial data communication signal **106** from the video data detector **91**. In step **1406**, the data error processor **99** determines whether a data error is detected in the content data bits **164** of the serial data communication signal **106**. If a data error is not detected in the content data bits **164** of the serial data communication signal **106**, the "NO" branch is followed to step **1412**, which is described below. If a data error is detected in the content data bits **164** of the serial data communication signal **106**, the "YES" branch is followed to step **1408**, in which the data error processor **99** determines whether the error is a correctable, typically one-bit, data error.

If the error is a correctable data error, the "YES" branch is followed from step **1408** to step **1410**, in which the data error processor **99** corrects the error. In step **1412**, the data error processor **99** assembles the content data bits **164** into a 9-bit error corrected data stream **108**. And in step **1414**, the data error processor **99** transmits the 9-bit error corrected data stream **108** to the protocol handler **93**. Step **1414** and the "NO" branch from step **1408** are followed by the "END" step **1416**, which returns step **1402** so that routine **1400** may repeat for the next serial data communication received from the video data detector **91**.

FIG. 15 is a logic flow diagram illustrating routine **1500** for a data handler **89** of the protocol handler **93** that is configured to respond to short addresses. Routine **1500** begins in step **1502**, and in step **1504** the data handler **89** receives the 9-bit error corrected data stream **108** from the data error processor **99**. In step **1506**, the data handler **89** reads a 9-bit content word. In step **1508**, the data handler **89** determines whether the content word is an address word, preferably by checking to see whether the last data bit is a zero. If the content word is an address word, the "YES" branch is followed to routine **1510**, in which the data handler **89** process the address word. Routine **1510** is described below with reference to FIG. 16.

If the content word is not an address word (i.e., the content word is device-specific control data), the "NO" branch is followed from step **1508** to step **1512**, in which the data handler **89** determines whether it is in its active mode. That is, the data handler **89** determines whether it has previously been toggled to the active mode by receiving the short address for its associated data sink **97**. If the data handler **89** is in its active mode, the "YES" branch is followed from step **1512** to step **1514**, in which the data handler **89** translates the device-specific control data into the appropriate format for its associated data sink **97**. In step **1516**, the data handler **89** transmits the data sink format data **110** to its associated data sink **97**. Step **1516**, as well as routine **1510** and

the "NO" branch from step **1512**, are followed by the "END" step **1518**, which returns step **1502** so that routine **1500** may repeat for the next 9-bit content word.

FIG. 16 is a logic flow diagram illustrating routine **1510** for processing short address words. Routine **1510** begins in step **1602** following the "YES" branch from step **1508**, which is shown in FIG. 15. In step **1604**, the data handler **89** determines whether the received address is the short address that matches the short address assigned to its associated data sink **97**. If the received address matches the short address assigned to its associated data sink **97**, the "YES" branch is followed to step **1608**, in which the data handler **89** is set to the active mode. Because device-specific control data for the data sink **97** will follow immediately, the data handler **89** typically sends a "begin data packet" message to its associated data sink **97** in step **1610**. Step **1610** is followed by the "RETURN" step **1616**, which returns to step **1518**, shown on FIG. 15.

Referring again to step **1604**, if the received address does not match the assigned short address, the "NO" branch is followed to step **1612**, in which the data handler **89** is set to the inactive mode. Because this signals the end of a data packet, which means that device-specific control data for the data sink **97** will not follow immediately, the data handler **89** typically sends an "end data packet" message to its associated data sink **97** in step **1614**. Step **1614** is followed by the "RETURN" step **1616**, which returns to step **1518**, shown on FIG. 15.

FIG. 17 is a logic flow diagram illustrating routine **1700** for a data handler **89** of the protocol handler **93** that is configured to respond to long addresses. Routine **1700** begins in step **1702**, and in step **1704** the data handler **89** receives the 9-bit error corrected data stream **108** from the data error processor **99**. In step **1706**, the data handler **89** reads a 9-bit content word. In step **1708**, the data handler **89** determines whether the content word is an address word, preferably by checking to see whether the last data bit is a

zero. If the content word is an address word, the "YES" branch is followed to routine **1710**, in which the data handler **89** process the address word. Routine **1710** is described below with reference to FIG. 18.

If the content word is an address word (i.e., the content word is device-specific control data), the "NO" branch is followed from step **1708** to step **1712**, in which the data handler **89** determines whether it is in its data active mode. That is, the data handler **89** determines whether it has previously been toggled to its data active mode by receiving the long address for its associated data sink **97**. If the data handler **89** is in its data active mode, the "YES" branch is followed from step **1712** to step **1714**, in which the data handler **89** translates the device-specific control data into the appropriate format for its associated data sink **97**. In step **1716**, the data handler **89** transmits the data sink format data **110** to its associated data sink **97**. Step **1716** is followed by the "END" step **1722**, which returns step **1702** so that routine **1700** may repeat for the next 9-bit content word.

If the data handler **89** is not in its data active mode, the "YES" branch is followed from step **1712** to step **1718**, in which the data handler **89** determines whether it is in its long address collection mode. If the data handler **89** is in its long address collection mode, the "YES" branch is followed to step **1720**, in which the data handler **89** collects the data bits of the current content word as part of a long address. If the data handler **89** is not in its long address collection mode, the "NO" branch is followed to the "END" step **1722**, which returns step **1702** so that routine **1700** may repeat for the next 9-bit content word.

FIG. 18 is a logic flow diagram illustrating routine **1710** for processing long address words. Routine **1710** begins in step **1702** following the "YES" branch from step **1708**, which is shown in FIG. 17. In step **1804**, the data handler **89** determines whether the received content word is a begin long address message, preferably by determining whether the received content word

is the short address (OFE) dedicated to this type of message. If the received content word is a begin long address message, the "YES" branch is followed to step **1806**, in which the data handler **89** is set to the long address collection mode.

Step **1806** is followed by step **1807**, in which the data handler **89** determines whether it is already in the data active mode. If the data handler **89** is already in the data active mode, the "YES" branch is followed to **1820**, in which the data handler is set to the data inactive mode. Because this signals the end of a data packet, which means that device-specific control data for the data sink **97** will not follow immediately, the data handler **89** typically sends an "end data packet" message to its associated data sink **97** in step **1822**. Step **1822** is followed by the "RETURN" step **1824**, which returns to step **1722**, shown in FIG. 17.

Referring again to step **1804**, if the received content word is not a begin long address message, the "NO" branch is followed to step **1808**, in which the data handler **89** determines whether the received content word is an end long address message, preferably by determining whether the received content word is the short address (OFF) dedicated to this type of message. If the received content word is not an end long address message, the "NO" branch is followed to step **1809**, in which the data collection mode for the data handler **89** is inactivated. Step **1809** is followed by step **1814**, in which the data handler **89** determines whether it is set to the data active mode. If the data handler **89** is set to the data active mode, the "YES" branch is followed to step **1820**, in which the data handler is set to the data inactive mode. Because this signals the end of a data packet, which means that device-specific control data for the data sink **97** will not follow immediately, the data handler **89** typically sends an "end data packet" message to its associated data sink **97** in step **1822**. Step **1822** is followed by the "RETURN" step **1824**, which returns to step **1722**, shown on FIG. 17.

Referring again to step **1808**, if the received content word is an end long address message, the "YES" branch is followed to step **1810**, in which the long address collection mode for data handler **89** is inactivated. In step **1812**, the data handler **89** determines whether the received long address (i.e., the long address collected in step **1720**, which is shown in FIG. 17) matches the long address assigned to its associated data sink **97**. If the received long address matches the long address assigned to its associated data sink **97**, the "YES" branch is followed to step **1816**, in which data handler **89** is set to the data active mode. Because device-specific control data for the data sink **97** will follow immediately, the data handler **89** typically sends a "begin data packet" message to its associated data sink **97** in step **1818**. Step **1818** is followed by the "RETURN" step **1824**, which returns to step **1722**, shown on FIG. 17.

Those skilled in the art will understand that the specific protocol illustrated in Tables 1-4 are just one example of many specific protocols that could be used to implement an addressing scheme using short addresses and long address in accordance with the present invention. In addition, the location of the data within the encoded video signal **104** may be varied somewhat without unduly affecting the performance of the system **100**. In particular, Microsoft Corporation has been granted permission by the Federal Communications Commission to encode digital data in lines 23-257 in field-1 and lines 285-519 in field-2 of a standard 525 line NTSC television broadcast signal. As shown in FIG. 10B and Tables 1-4 above, the preferred protocol only utilizes lines 23-237 in field-1 and lines 286-500 in field-2. This enhances compatibility of the encoded video signal **104** with MPEG-based video compression algorithms, which typically exclude line 285 and include a compressed representation of only 480 visible scan lines.

The invention thus provides a method and system for encoding control data for wireless controlled devices in connection with a video signal so that the actions of the controlled devices operate in synchronism with the programming

information defined by the video signal. Additional data may be transmitted encoded into the video signal for providing additional services, such as e-mail, foreign language subtitling, intercom capability, telephone pages, weather warnings, configuration data for a set-top box, and so forth. The protocol for the encoded data is addressable, forwardly compatible, error tolerant, and feasible to deploy in connection with a system that is primarily intended to be a children's entertainment product.

It should be understood that the foregoing relates only to specific embodiments of the invention, and that numerous changes may be made therein without departing from the spirit and scope of the invention as defined by the following claims.

CLAIMS

What is claimed is:

1. A method for encoding control data in a video signal defining a plurality of frames, each frame comprising a plurality of lines, comprising the steps of:

concatenating encoded data with the lines of the video signal to create an encoded video signal; and

configuring the encoded data to define content data in association with each frame, the content data defining,

a first address associated with a first device,

device-specific control data for the first device,

a second address associated with a second device, and

device-specific control data for the second device.

2. The method of Claim 1, further comprising the steps of:

in response to the first address, routing the device-specific control data for the first device to the first device;

controlling actions of the first device in accordance with the device-specific control data for the first device;

in response to the second address, routing the device-specific control data for the second device to the second device; and

controlling actions of the second device in accordance with the device-specific control data for the second device.

3. The method of Claim 2, wherein:

the video signal defines programming information comprising a scene displayed on a display device; and

the device-specific control data for the first device includes voice data and motor control data that causes the first device to behave as a character in the scene displayed on the display device.

4. The method of Claim 3, wherein the device-specific control data for the second device is selected from the following:

voice data that causes the second device to behave as a second character in the scene displayed on the display device;

motor control data that causes the second device to behave as a second character in the scene displayed on the display device;

electronic mail for a transmission to a computer system;

intercom information for transmission to an intercom system;

telephone paging information for transmission to a paging system;

language translation data displayed on the display device;

advertising information displayed on the display device;

subscription information displayed on the display device; and

emergency warning information displayed on the display device.

5. The method of Claim 4, wherein the first address comprises a first start-packet short address word and the second address comprises a second start-packet short address word, further comprising the step of:

interpreting the second start-packet short address word as a first end-packet short address word for with the first device.

6. The method of Claim 4, wherein the first address comprises a start-packet begin-long-address word, further comprising the step of configuring the content data to define:

a first occurrence of a long address associated with the first device;

a start-packet end-long-address word associated with the first device; and device-specific control data for the first device.

7. The method of Claim 1, further comprising the step of:

configuring the encoded data to define signal detection data, each signal detection word comprising,

a plurality of data bits, and

a plurality of error correction bits defining a correction sequence that allows a single-bit error in the data bits to be detected and corrected.

8. The method of Claim 7, wherein:

the video signal comprises a plurality of two-field interlaced frames; and

the encoded data of each field of the video signal defines a signal detection word consisting essentially of four data bits and three error correction bits.

9. The method of Claim 1, wherein the content data comprises a plurality of content words, each content word comprising:

a plurality of data bits; and

a plurality of error correction bits defining a correction sequence that allows errors in the data bits to be detected and corrected.

10. The method of Claim 9, wherein each content word consists essentially of nine data bits and seven error correction bits.

11. The method of Claim 1, further comprising the step of:

configuring the encoded data to define signal detection data comprising a signal detection word encoded into each of a plurality of the frames of the video signal; and

a consecutive series of the signal detection words defines a dynamic validation sequence in which each signal detection word varies in at least two bits from the immediately preceding signal detection word.

12. The method of Claim 11, wherein the dynamic validation sequence comprises the binary representation of 8, 1, 10, 3, 12, 5, 14, 7.

13. The method of Claim 1, wherein:

the encoded data comprises a plurality of line signals; and

each line signal is located in the horizontal overscan portion of one of the lines of the video signal.

14. The method of Claim 13, wherein each line of the video signal comprises a color burst portion and a visible raster portion, and wherein each line signal comprises a pulse located between the color burst portion and the visible raster portion.

15. The method of Claim 14, wherein each pulse defines a single bit of the encoded data.

16. The method of Claim 15, wherein:

the video signal comprises a plurality of two-field interlaced frames; and

the encoded data of each field of the video signal defines a 7-bit signal detection word and 13 16-bit content words.

17. The method of Claim 14, wherein each pulse is modulated to define a plurality of bits of the encoded data.

18. The method of Claim 13, wherein each line of the video signal comprises a color burst portion, a visible raster portion, and a horizontal blanking interval, and wherein each line signal comprises:

a pre-visible pulse located between the color burst portion and the visible raster portion; and

a post-visible pulse located after the visible raster portion and before the horizontal blanking interval.

19. The method of Claim 18, wherein:

each pre-visible pulse defines a single bit of the encoded data; and

each post-visible pulse defines a single bit of the encoded data.

20. The method of Claim 18, wherein:

each pre-visible pulse is modulated to define a plurality of bits of the encoded data; and

each post-visible pulse is modulated to define a plurality of bits of the encoded data.

21. An encoded video signal comprising:

a video signal defining a plurality of frames, each frame comprising a plurality of lines;

encoded data concatenated with the lines of the video signal, the encoded data defining signal detection data and content data in association with each frame;

the signal detection data defining a signal detection word encoded into each frame such that a consecutive series of the signal detection words defines a dynamic validation sequence in which each signal detection word varies in at least two bits from the immediately preceding signal detection word; and

the content data defining,

a first start-packet short address word associated with a first device,

device-specific control data for the first device,

a second start-packet short address word associated with a second device, and

device-specific control data for the second device.

22. The encoded video signal of Claim 21, wherein the content data further defines:

a start-packet start-long-address word associated with a third device;

a first occurrence of a long address associated with the third device;

a start-packet end-long-address word associated with the third device; and device-specific control data for the third device.

23. The encoded video signal of Claim 21, wherein:

the video signal defines programming information; and

the device-specific control data for the first device causes first device to behave as a character in a scene defined by the programming information.

24. The encoded video signal of Claim 21, wherein the encoded data comprises a plurality of line signals wherein each line signal is located in the horizontal overscan portion of one of the lines of the video signal.

25. The encoded video signal of Claim 21, wherein:

the content data comprises a plurality of content words;

the signal detection data comprises a plurality of signal detection words; and

each signal detection word and each content word comprises,

a plurality of data bits, and

a plurality of error correction bits defining a correction sequence that allows errors in the data bits to be detected and corrected.

26. A storage medium including a computer program which, when executed by a computer-based video data encoder, causes the video data encoder to perform the steps of:

receiving a video signal defining a plurality of frames, each frame comprising a plurality of lines, the video signal defining programming information;

concatenating encoded data with a plurality of the lines of a plurality of the frames of the video signal to create an encoded video signal;

the encoded data defining content data in association with each frame;

the content data defining,

a first start-packet short address word associated with a first device,

device-specific control data for causing the first device to behave as a character in a scene defined by the programming information,

a second start-packet short address word associated with a second device, and

device-specific control data for the second device; and

transmitting the encoded video signal to a receiving device.

27. The storage medium of Claim 26, wherein the content data further defines:

a start-packet start-long-address word associated with a third device;

a long address associated with the third device;

a start-packet end-long-address word associated with the third device; and device-specific control data for the third device.

28. The storage medium of Claim 26, wherein:

the encoded data defines signal detection data comprising a signal detection word encoded into each of a plurality of frames of the video signal; and

a consecutive series of the signal detection words defines a dynamic validation sequence in which each signal detection word varies in at least two bits from the immediately preceding signal detection word.

29. The storage medium of Claim 26, wherein the encoded data comprises a plurality of line signals wherein each line signal is inserted in the horizontal overscan portion of a line of the video signal.

30. The storage medium of Claim 26, wherein:

the content data comprises a plurality of content words and the signal detection data comprises a plurality of signal detection words, each signal detection word and each content word comprising,

a plurality of data bits, and

a plurality of error correction bits defining a correction sequence that allows errors in the data bits to be detected and corrected.

31. A system for encoding data in association with a video signal, comprising a video data encoder functionally connected to a video source and operative for:

receiving a video signal from the video source, the video signal defining a plurality of frames, each frame comprising a plurality of lines;

concatenating encoded data with a plurality of the lines of a plurality of the frames of the video signal to create an encoded video signal;

the encoded data defining a signal detection word and at least one content word in association with each of a plurality of the frames; and

the content words defining,

a first start-packet short address word associated with a first device,

device-specific control data for the first device,

a second start-packet short address word associated with a second device, and

device-specific control data for the second device.

32. The system of Claim 31, wherein:

the video signal defines programming information; and

the device-specific control data for the first device causes first device to behave as a character in a scene defined by the programming information.

33. The system of Claim 32, wherein the encoded data comprises a plurality of line signals wherein each line signal is located in the horizontal overscan portion of a line of the video signal.

34. The system of Claim 33, wherein each line of the video signal comprises a color burst portion and a visible raster portion, and wherein each line signal comprises a pulse located between the color burst portion and the visible raster portion.

35. The system of Claim 34, wherein each pulse defines a single bit of the encoded data.

36. The system of Claim 35, wherein:

the video signal defines a plurality of two-field interlaced frames; and

the encoded data of each field of the video signal defines a signal detection word and thirteen content words.

37. The system of Claim 36, wherein each pulse is modulated to define a plurality of bits of the encoded data.

38. The system of Claim 36, wherein each line of the video signal comprises a color burst portion, a visible raster portion, and a horizontal blanking interval, and wherein each line signal comprises:

a pre-visible pulse located between the color burst portion and the visible raster portion; and

a post-visible pulse located after the visible raster portion and before the horizontal blanking interval.

39. The system of Claim 38, wherein:

each pre-visible pulse defines a single bit of the encoded data; and

each post-visible pulse defines a single bit of the encoded data.

40. The system of Claim 38, wherein:

each pre-visible pulse is modulated to define a plurality of bits of the encoded data; and

each post-visible pulse is modulated to define a plurality of bits of the encoded data.

41. The system of Claim 30, further comprising a data decoder functionally connected to the video data encoder and operative for:

receiving the encoded video signal from the video data encoder;

detecting the presence of the signal detection data;

extracting the content data from the encoded video signal; and

assembling the content data into a serial data communication signal.

42. The system of Claim 41, further comprising a data error processor functionally connected to the data decoder and operative for:

receiving the serial data communication signal from the data decoder;

parsing the serial data communication signal into data bits and error corrections bits;

analyzing the error correction bits to detect errors in the data bits;

correcting detected errors in the data bits; and

assembling the corrected data bits into an error corrected data stream.

43. The system of Claim 42, further comprising a protocol handler functionally connected to the data error processor and operative for:

receiving the error corrected data stream;

detecting the first start-packet short address word associated with a first device;

in response to detecting the first start-packet short address word associated with the first device, beginning the routing of subsequently received device-specific control data to the first device;

detecting the second start end-packet short address word associated with the second device; and

in response to detecting the second start end-packet short address word associated with the second device,

discontinuing the routing of subsequently received device-specific control data to the first device, and

beginning the routing of subsequently received device-specific control data to the second device.

44. The system of Claim 43, wherein the protocol handler is further operative for:

detecting a start-packet start-long-address word;

detecting a first occurrence of a long address associated with a third device;

detecting a start-packet end-long-address word;

beginning the routing of subsequently received device-specific control data to the third device;

detecting a further address word; and

in response to detecting the further address word, discontinuing the routing of subsequently received device-specific control data to the third device.

45. The system of Claim 43, wherein the device-specific control data for the first, second, and third devices are selected from the following:

voice data for transmission to a controlled device, the voice data configured to cause the controlled device to behave as a character in a scene defined by programming information defined by the video signal;

motor control data for transmission to a controlled device, the motor control data configured to cause the controlled device to behave as a character in a scene defined by programming information defined by the video signal;

electronic mail for a transmission to a computer system;

intercom information for transmission to an intercom system;

telephone paging information for transmission to a paging system;

language translation data for transmission to a display device;

advertising information for transmission to a display device;

subscription information for transmission to a display device; and

emergency warning information for transmission to a display device.

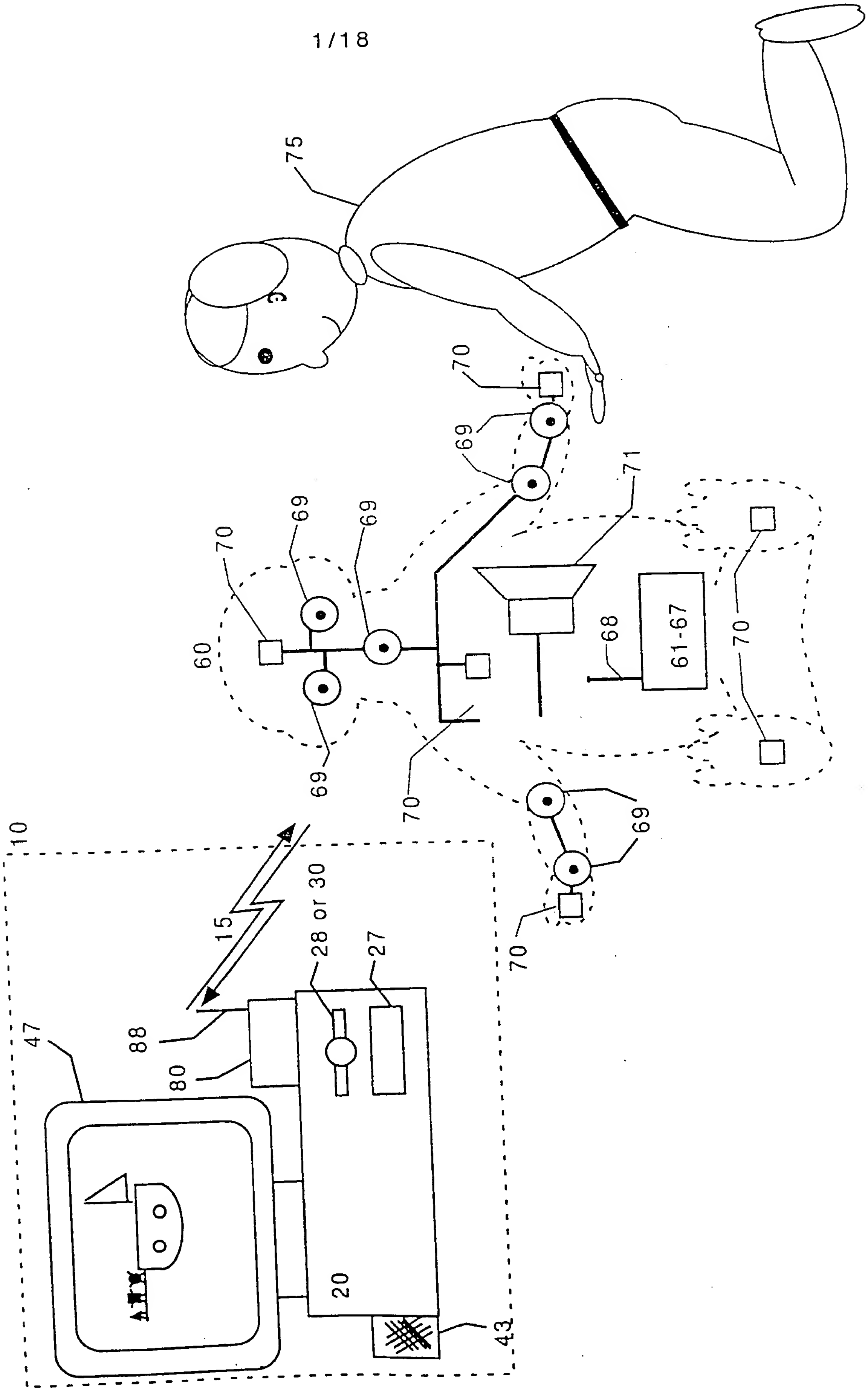

75
70
69
69
71
70
69
69
60
68
61-67
70
69
70
69
10
15
28 or 30
27
70
88
47
80
20
43

FIG. 1

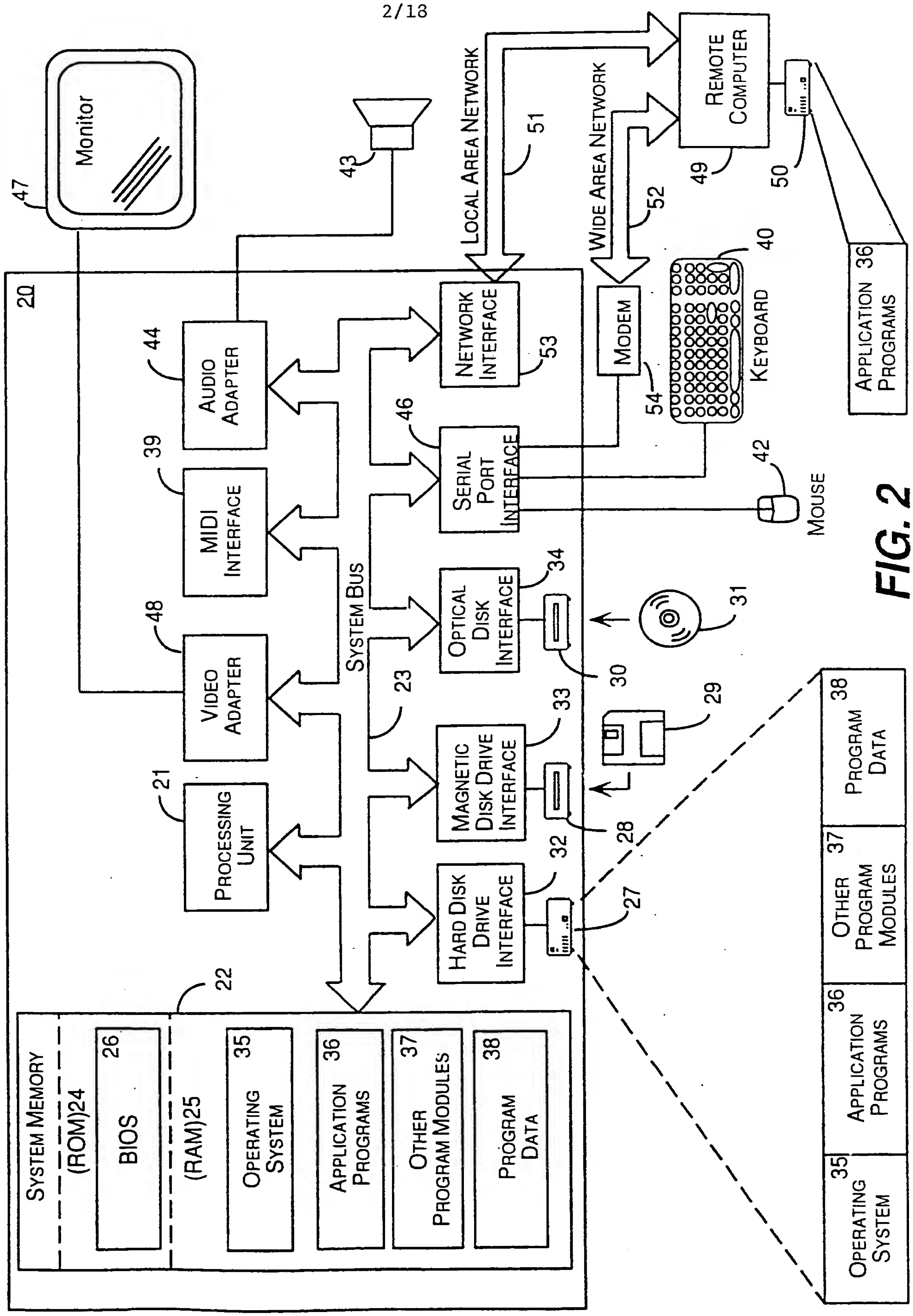
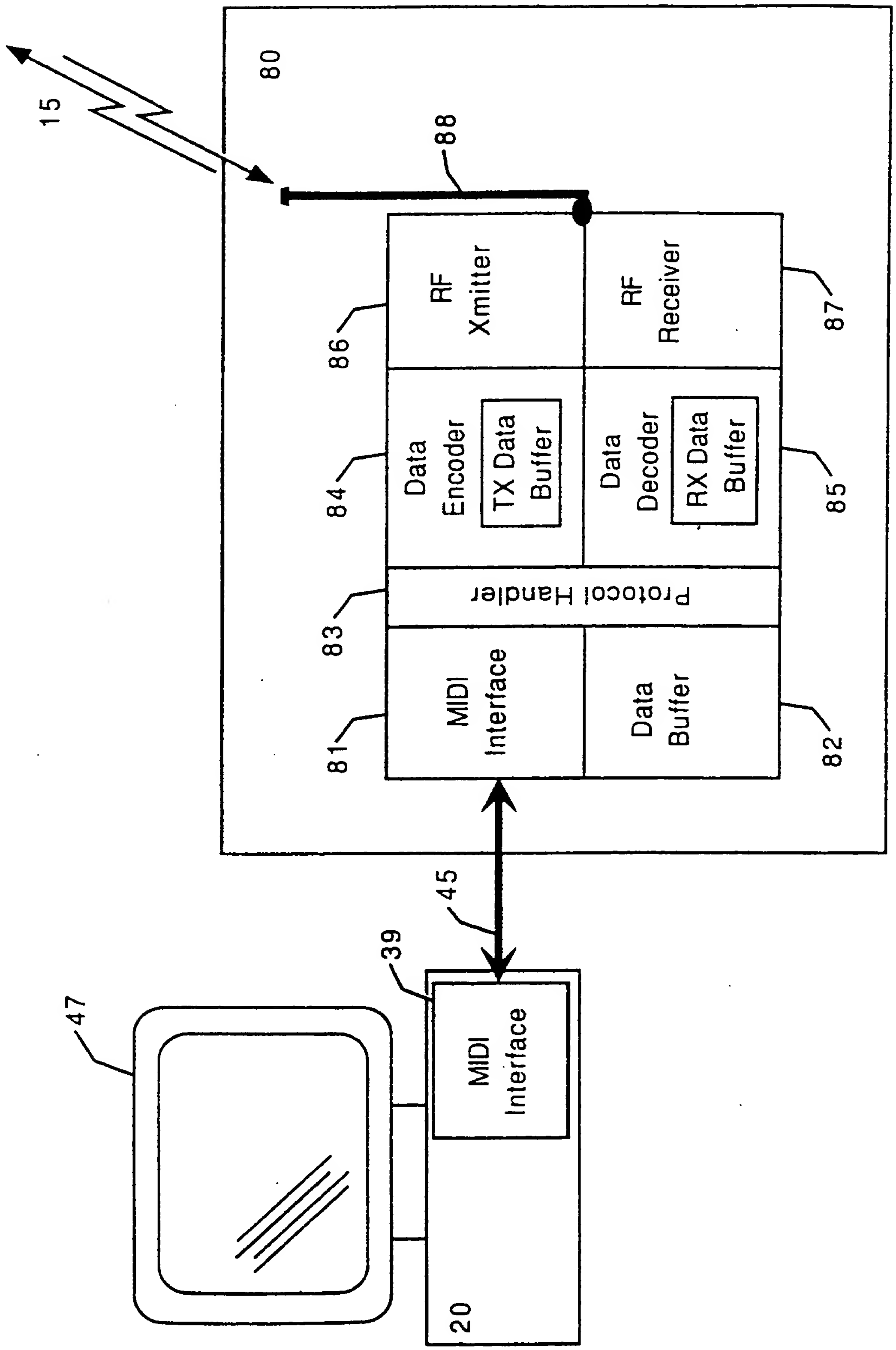

Monitor
47
43
Local Area Network
51
Wide Area Network
52
Remote Computer
49
50
20
Audio Adapter
44
MIDI Interface
39
Video Adapter
48
Processing Unit
21
System Bus
23
Network Interface
53
Modem
54
Serial Port Interface
46
Keyboard
40
Mouse
42
Application Programs
36
Optical Disk Interface
34
30
31
Magnetic Disk Drive Interface
33
28
29
Hard Disk Drive Interface
32
27
System Memory
22
(ROM)24
BIOS
26
(RAM)25
Operating System
35
Application Programs
36
Other Program Modules
37
Program Data
38
Operating System
35
Application Programs
36
Other Program Modules
37
Program Data
38

FIG. 2



15
80
88
RF Xmitter
RF Receiver
86
87
Data Encoder
TX Data Buffer
Data Decoder
RX Data Buffer
84
85
Protocol Handler
83
MIDI Interface
Data Buffer
81
82
45
39
MIDI Interface
47
20

Fig. 3

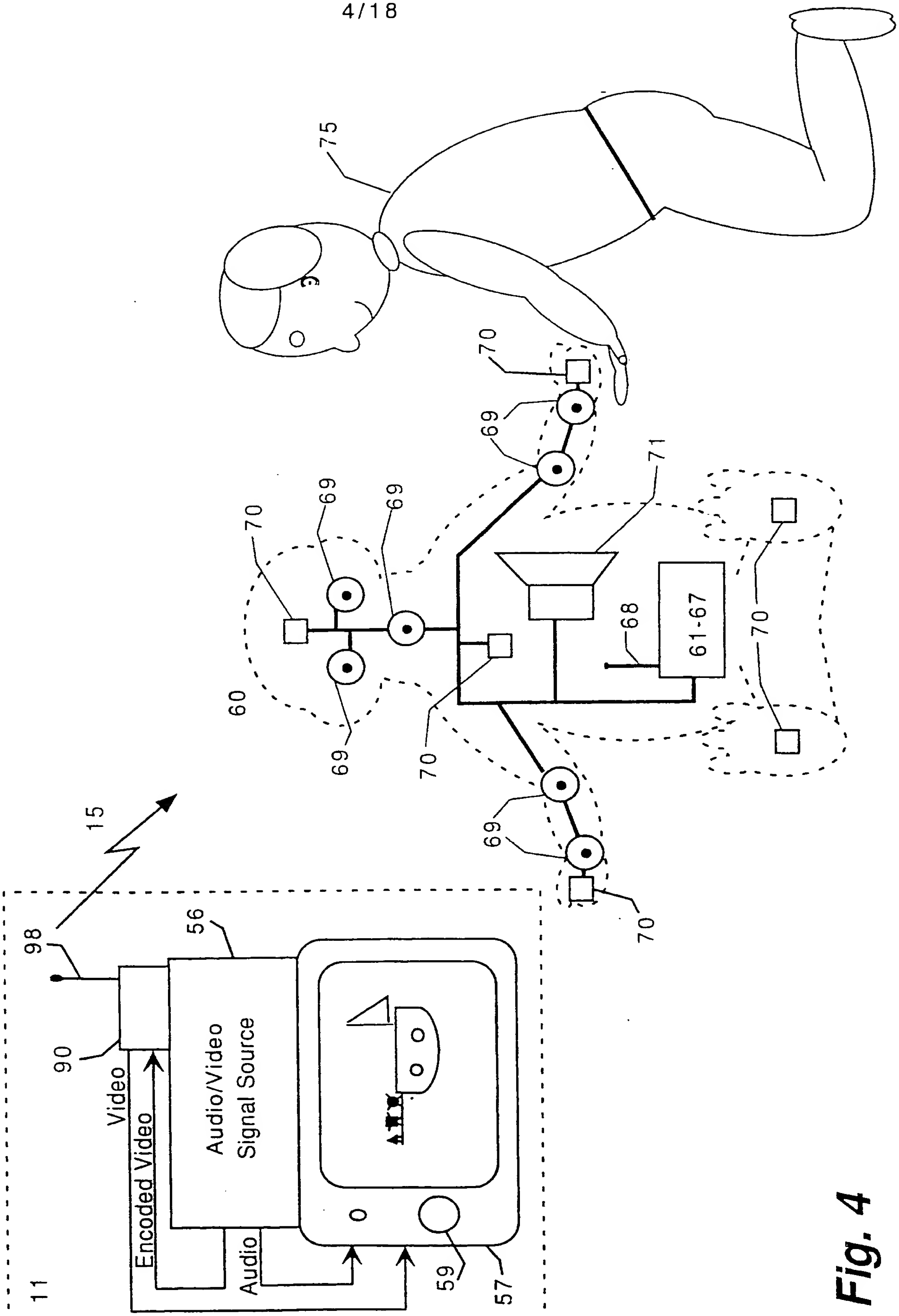

75
70
69
69
71
70
69
69
60
61-67
68
70
70
69
15
69
70
98
56
90
Video
Encoded Video
Audio/Video
Signal Source
Audio
11
59
57

Fig. 4

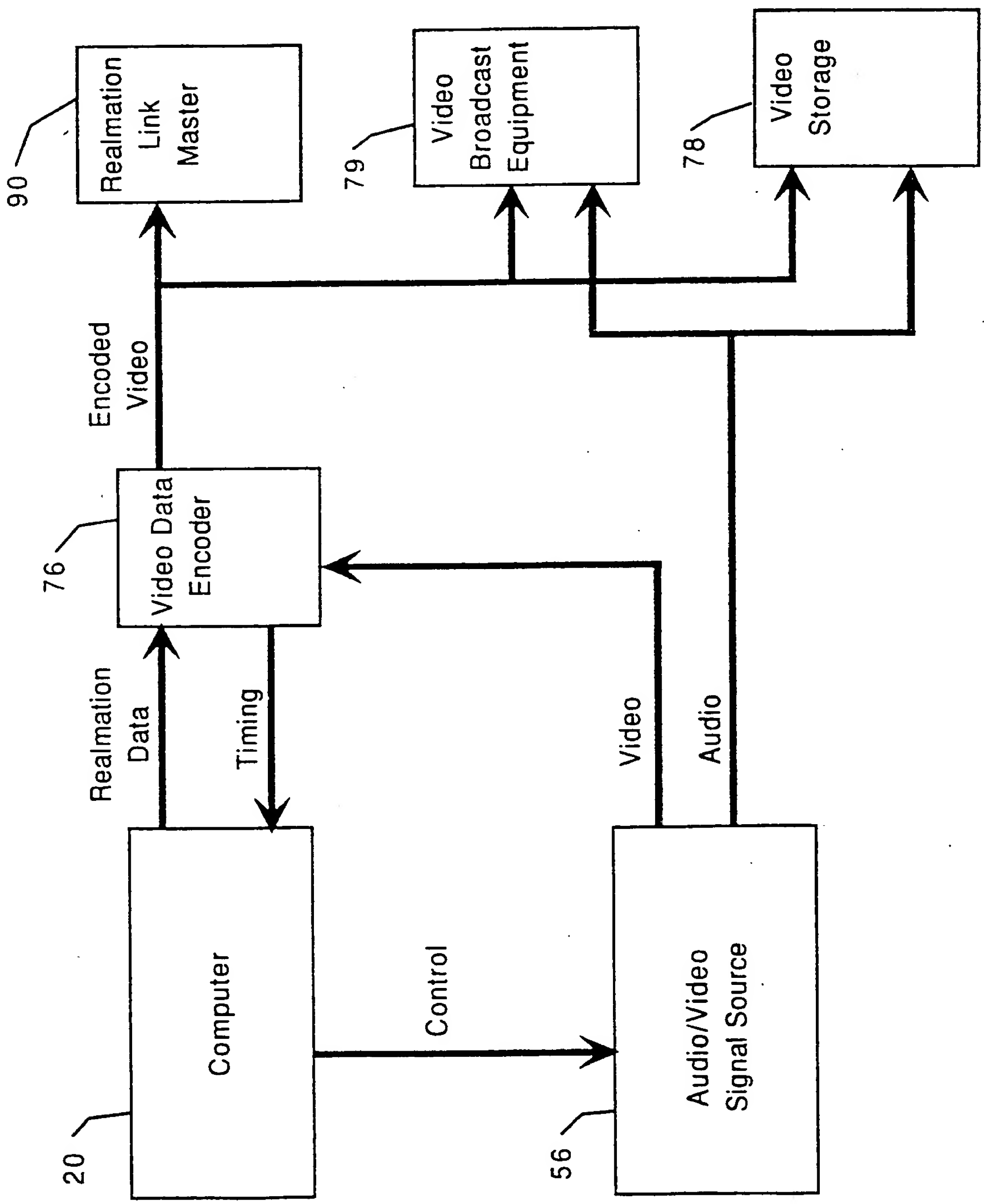

Realmation Link Master
90
Video Broadcast Equipment
79
Video Storage
78
Encoded Video
Video Data Encoder
76
Realmation Data
Timing
Video
Audio
Computer
20
Control
Audio/Video Signal Source
56

Fig. 5

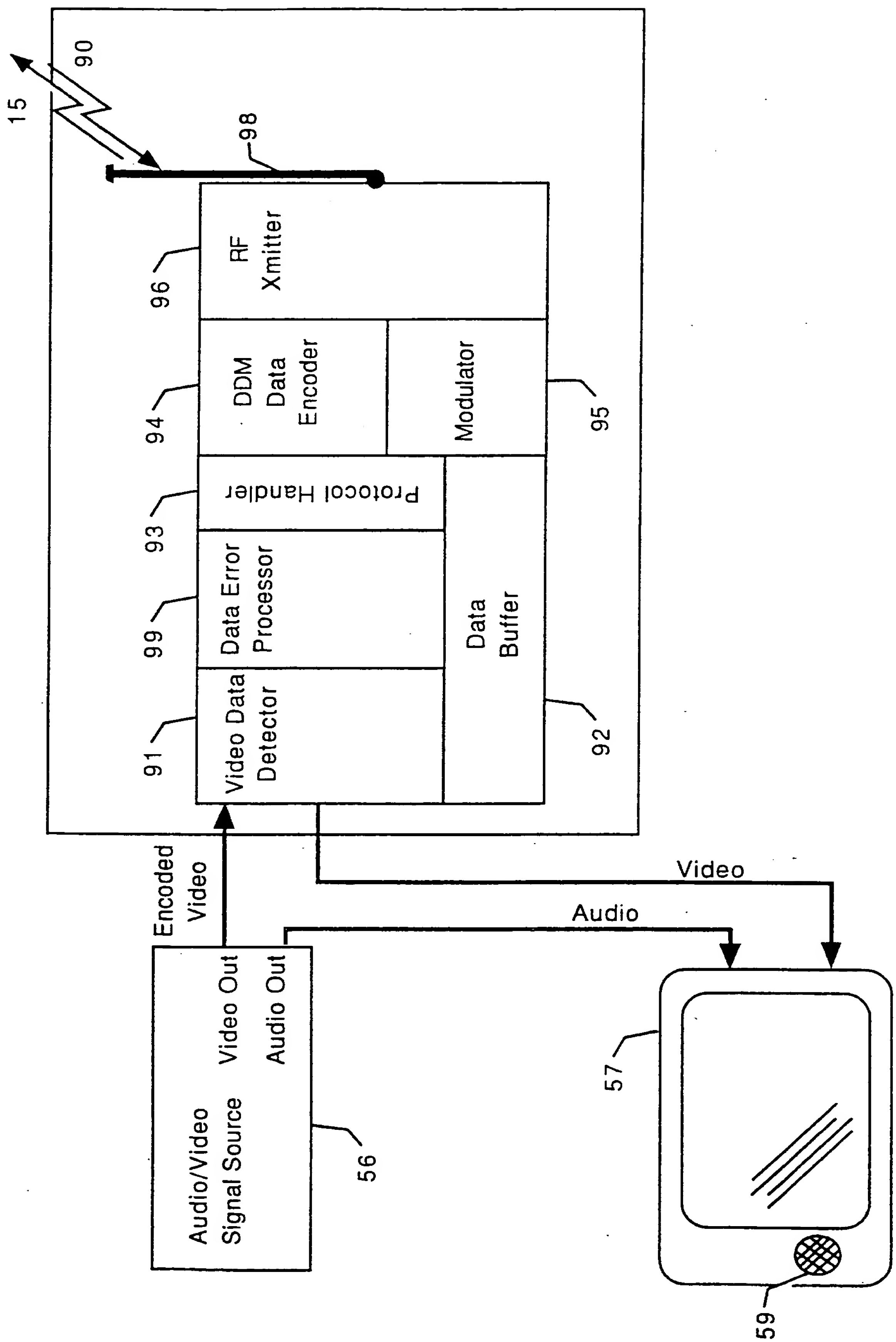

15
90
98
RF
Xmitter
96
DDM
Data
Encoder
94
Modulator
95
Protocol Handler
93
Data Error
Processor
99
Data
Buffer
92
Video Data
Detector
91
Encoded
Video
Video
Audio
Audio/Video
Signal Source
Video Out
Audio Out
56
57
59

Fig. 6

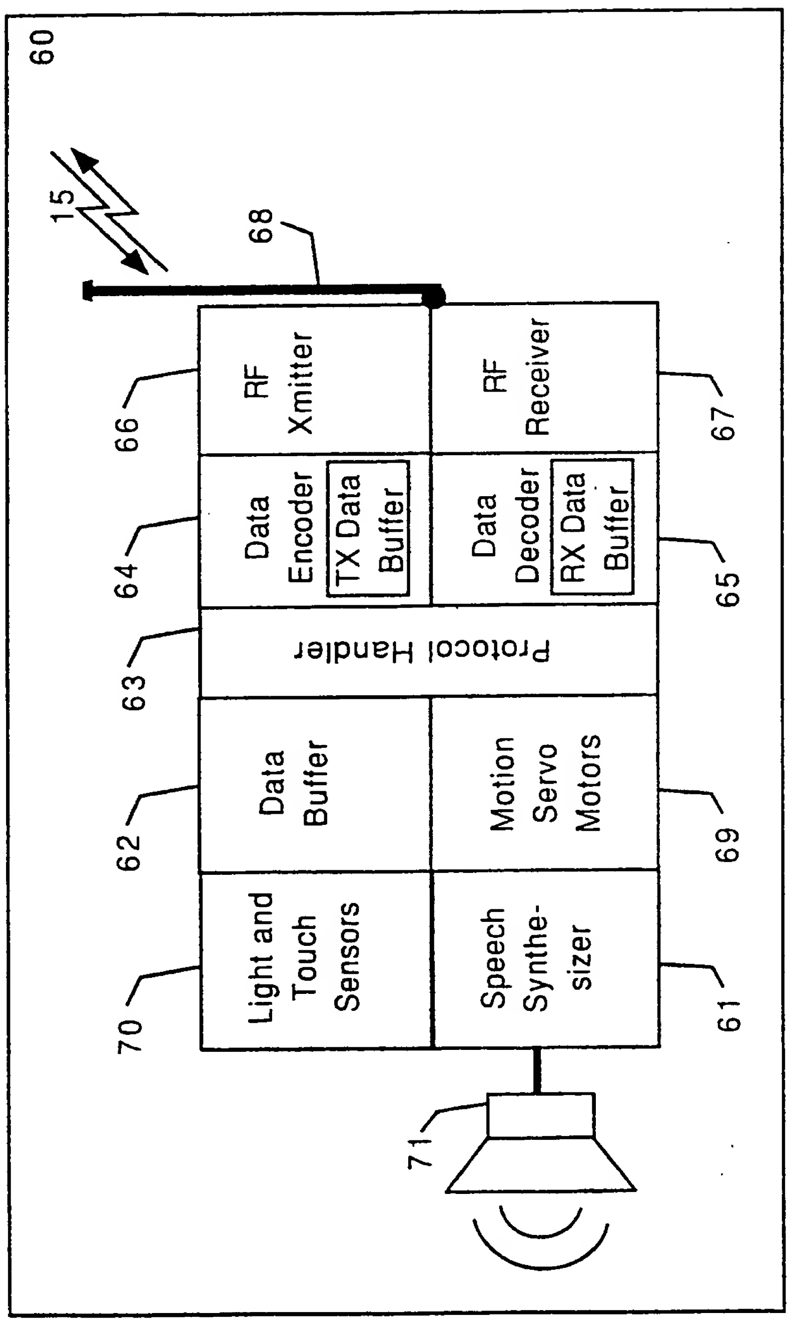
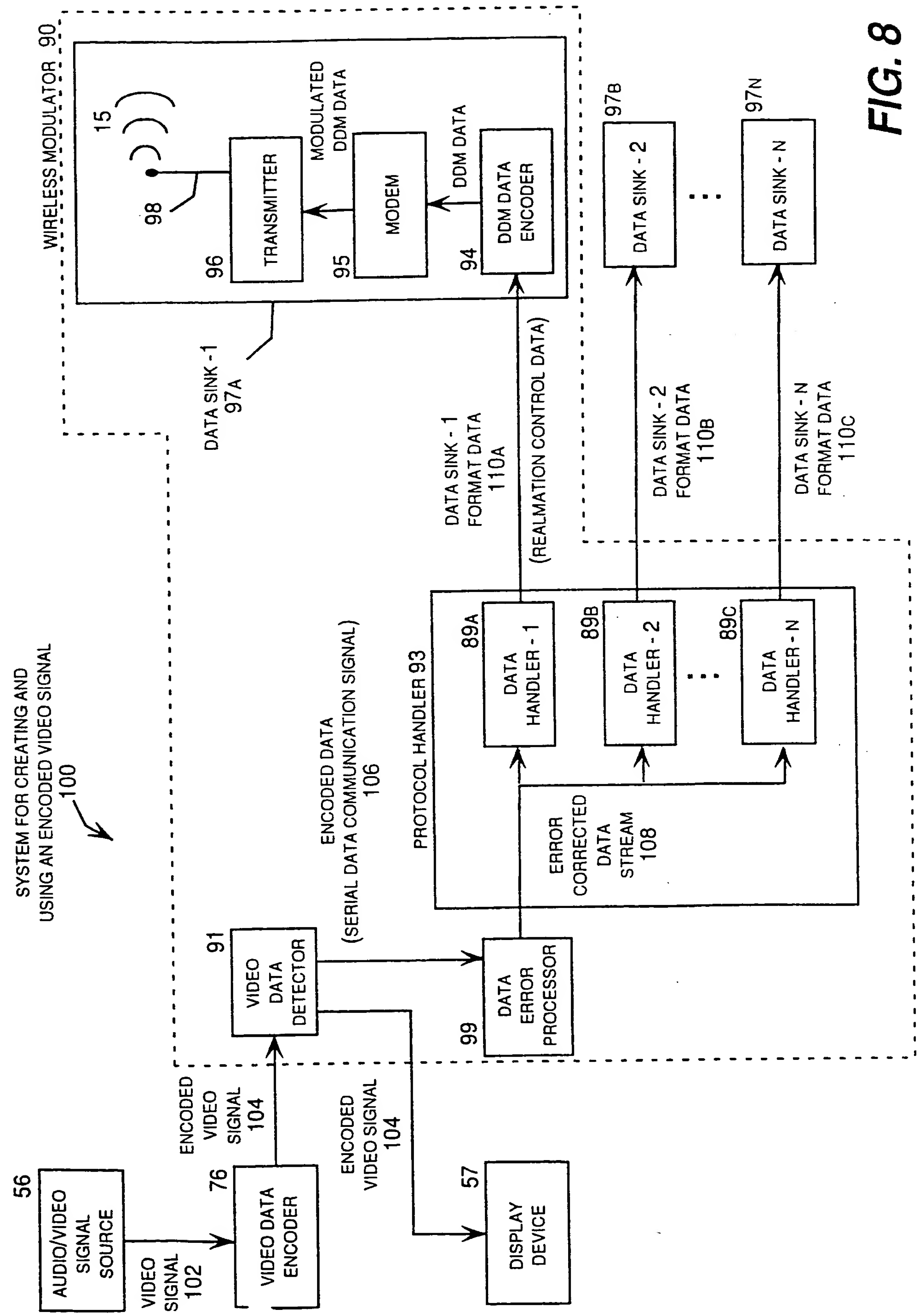

60
15
68
66
RF Xmitter
64
Data Encoder
TX Data Buffer
63
Protocol Handler
62
Data Buffer
70
Light and Touch Sensors
67
RF Receiver
65
Data Decoder
RX Data Buffer
69
Motion Servo Motors
61
Speech Synthe- sizer
71

Fig. 7


SYSTEM FOR CREATING AND USING AN ENCODED VIDEO SIGNAL
100
56
AUDIO/VIDEO SIGNAL SOURCE
VIDEO SIGNAL 102
76
VIDEO DATA ENCODER
ENCODED VIDEO SIGNAL 104
ENCODED VIDEO SIGNAL 104
57
DISPLAY DEVICE
91
VIDEO DATA DETECTOR
ENCODED DATA (SERIAL DATA COMMUNICATION SIGNAL) 106
99
DATA ERROR PROCESSOR
PROTOCOL HANDLER 93
ERROR CORRECTED DATA STREAM 108
89A
DATA HANDLER - 1
89B
DATA HANDLER - 2
89C
DATA HANDLER - N
DATA SINK - 1 FORMAT DATA 110A
(REALMATION CONTROL DATA)
DATA SINK - 2 FORMAT DATA 110B
DATA SINK - N FORMAT DATA 110C
WIRELESS MODULATOR 90
DATA SINK -1 97A
15
98
96
TRANSMITTER
MODULATED DDM DATA
95
MODEM
DDM DATA
94
DDM DATA ENCODER
97B
DATA SINK - 2
97N
DATA SINK - N
FIG. 8

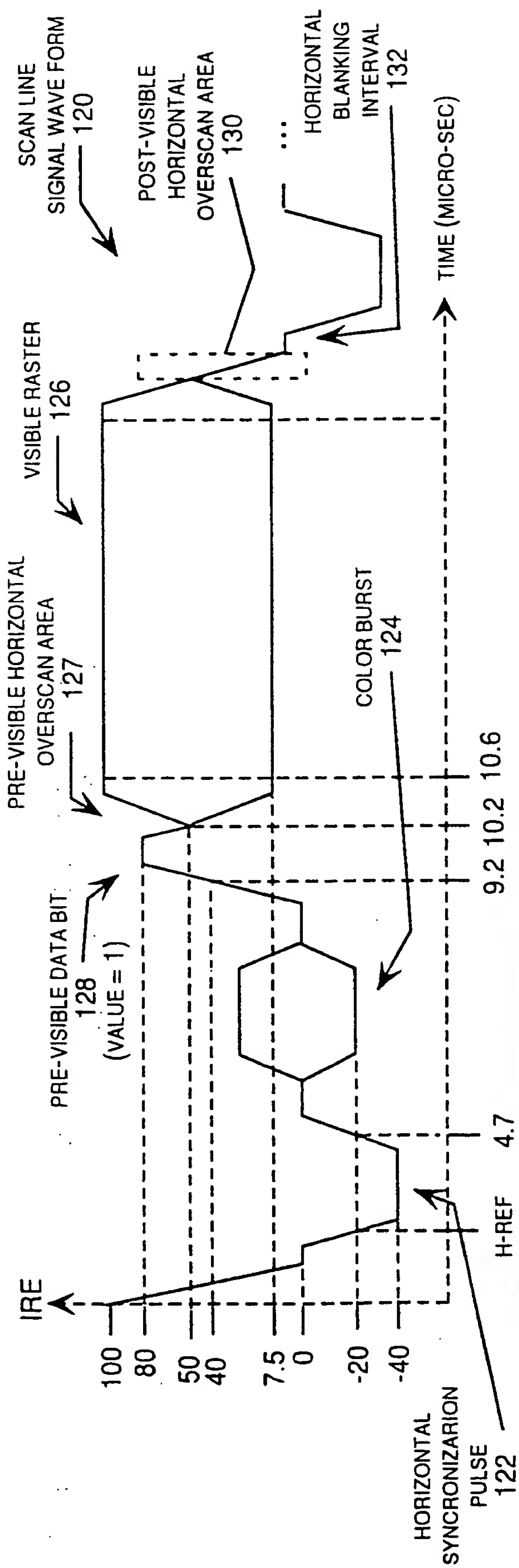

SCAN LINE
SIGNAL WAVE FORM
120
POST-VISIBLE
HORIZONTAL
OVERSCAN AREA
130
HORIZONTAL
BLANKING
INTERVAL
132
TIME (MICRO-SEC)
VISIBLE RASTER
126
PRE-VISIBLE HORIZONTAL
OVERSCAN AREA
127
COLOR BURST
124
PRE-VISIBLE DATA BIT
128
(VALUE = 1)
9.2 10.2 10.6
4.7
H-REF
ONE SCAN LINE
IRE
100
80
50
40
7.5
0
-20
-40
HORIZONTAL
SYNCRONIZARION
PULSE
122

FIG. 9A

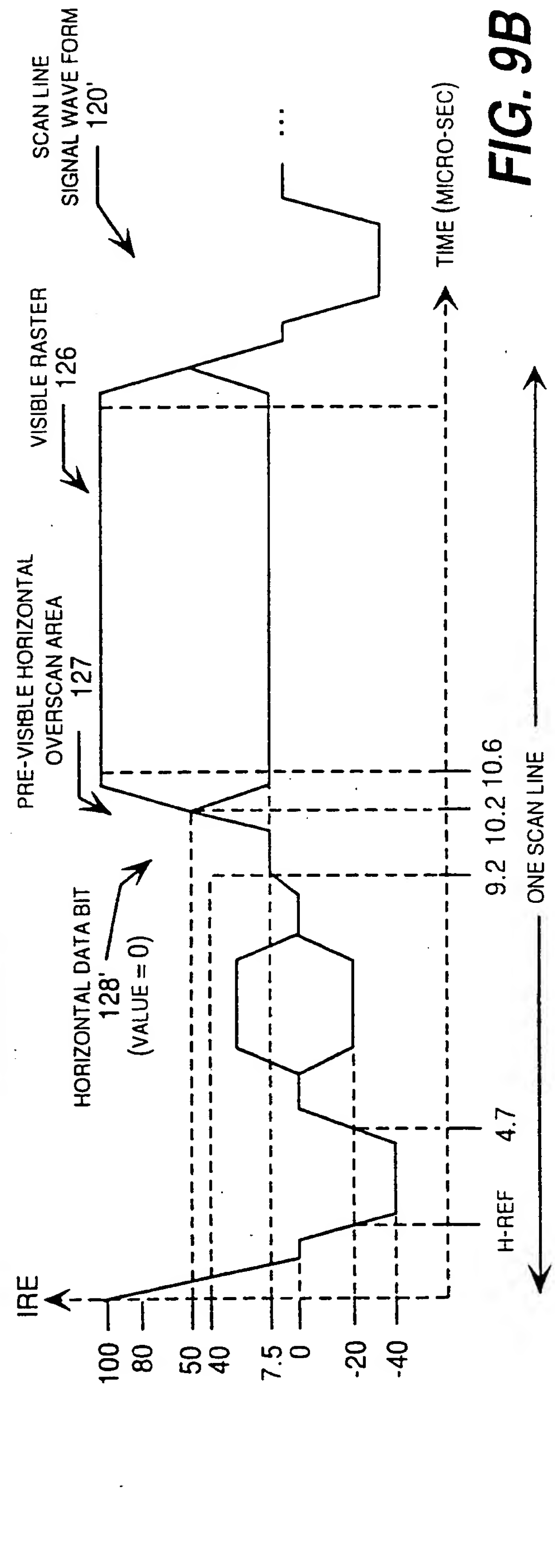

SCAN LINE
SIGNAL WAVE FORM
120'
TIME (MICRO-SEC)
VISIBLE RASTER
126
PRE-VISIBLE HORIZONTAL
OVERSCAN AREA
127
HORIZONTAL DATA BIT
128'
(VALUE = 0)
9.2 10.2 10.6
4.7
H-REF
ONE SCAN LINE
IRE
100
80
50
40
7.5
0
-20
-40

FIG. 9B

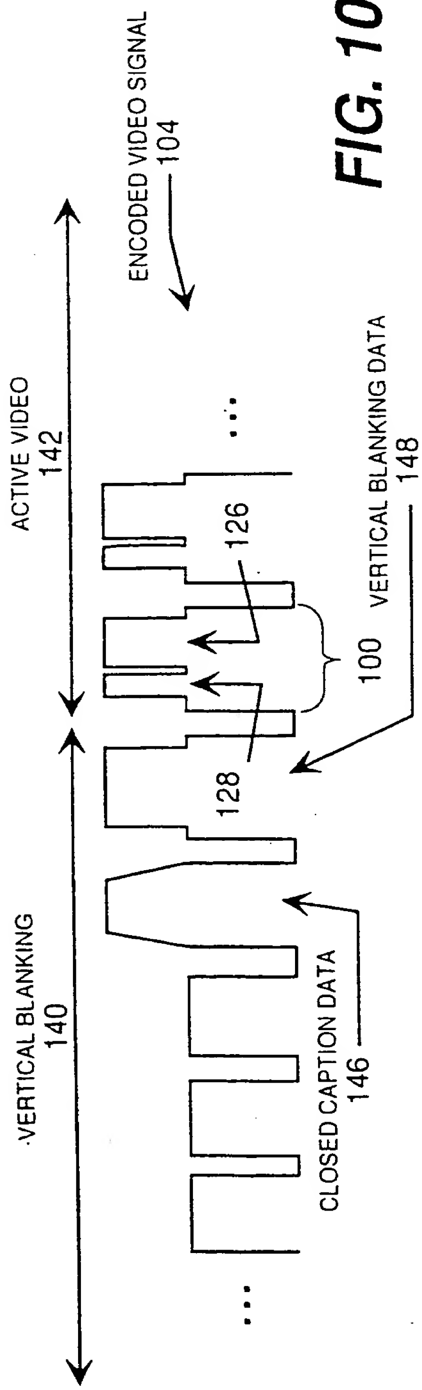


FIG. 10A

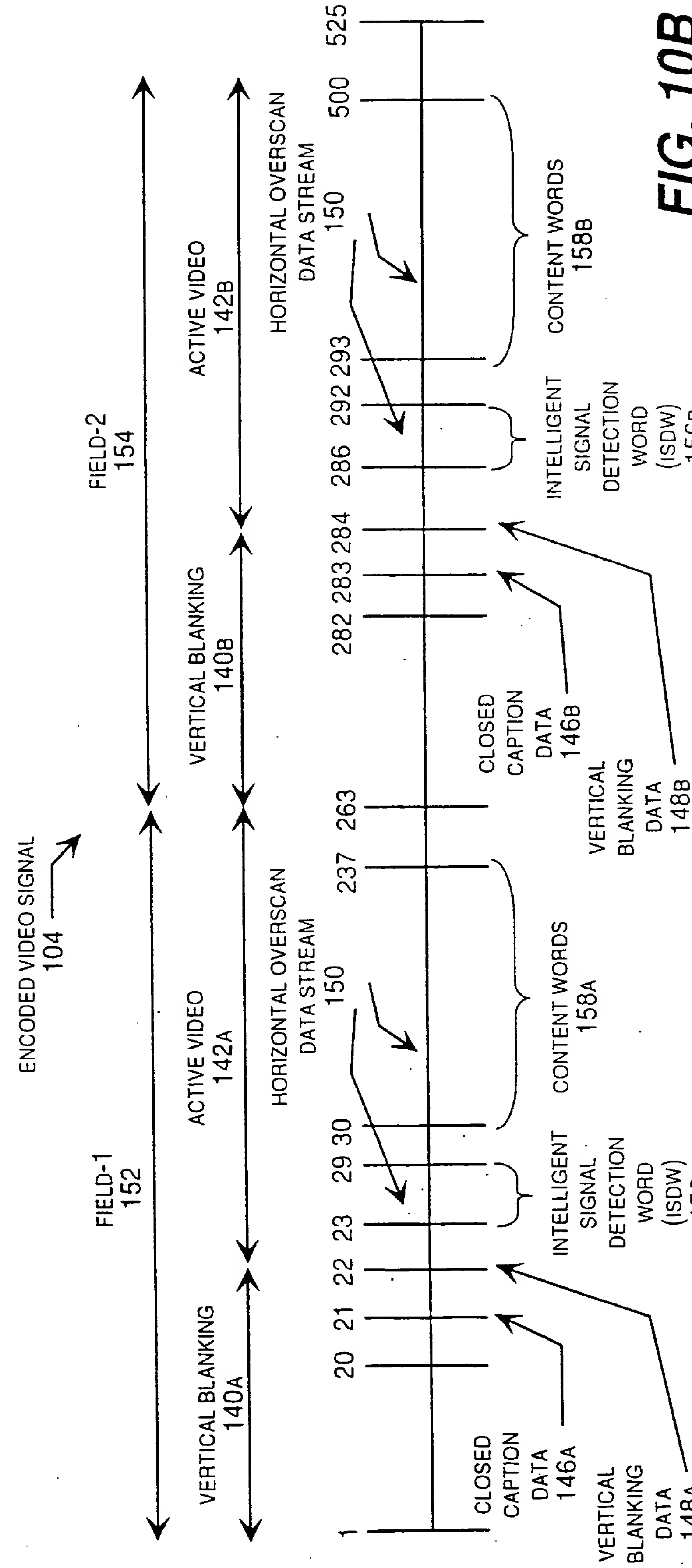


FIG. 10B

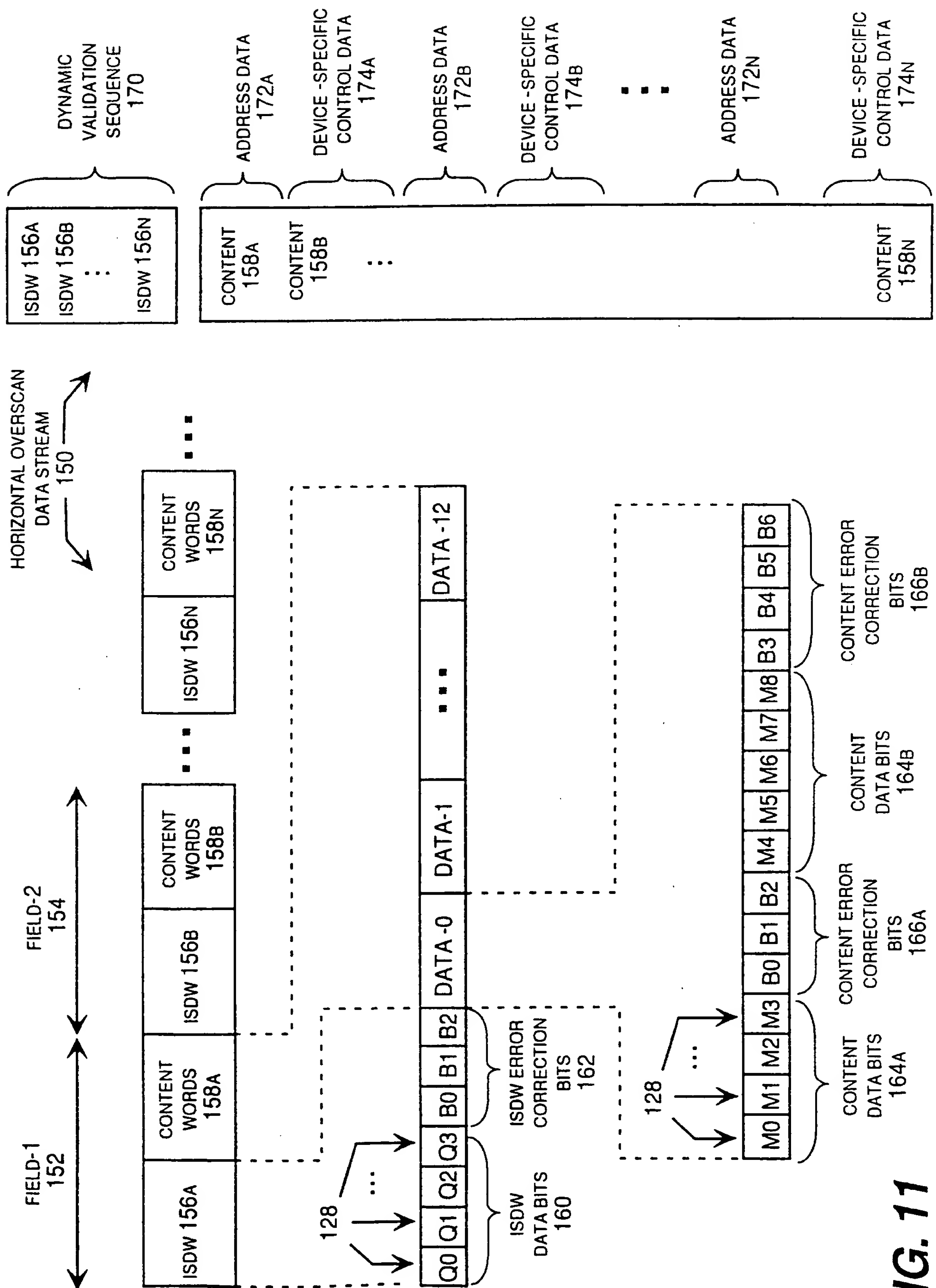

DYNAMIC VALIDATION SEQUENCE 170
ADDRESS DATA 172A
DEVICE-SPECIFIC CONTROL DATA 174A
ADDRESS DATA 172B
DEVICE-SPECIFIC CONTROL DATA 174B
ADDRESS DATA 172N
DEVICE-SPECIFIC CONTROL DATA 174N
ISDW 156A
ISDW 156B
ISDW 156N
CONTENT 158A
CONTENT 158B
CONTENT 158N
HORIZONTAL OVERSCAN DATA STREAM 150
FIELD-1 152
FIELD-2 154
ISDW 156A
CONTENT WORDS 158A
ISDW 156B
CONTENT WORDS 158B
ISDW 156N
CONTENT WORDS 158N
Q0 Q1 Q2 Q3 B0 B1 B2
DATA-0
DATA-1
DATA-12
128
ISDW DATA BITS 160
ISDW ERROR CORRECTION BITS 162
M0 M1 M2 M3 B0 B1 B2 M4 M5 M6 M7 M8 B3 B4 B5 B6
128
CONTENT DATA BITS 164A
CONTENT ERROR CORRECTION BITS 166A
CONTENT DATA BITS 164B
CONTENT ERROR CORRECTION BITS 166B

FIG. 11

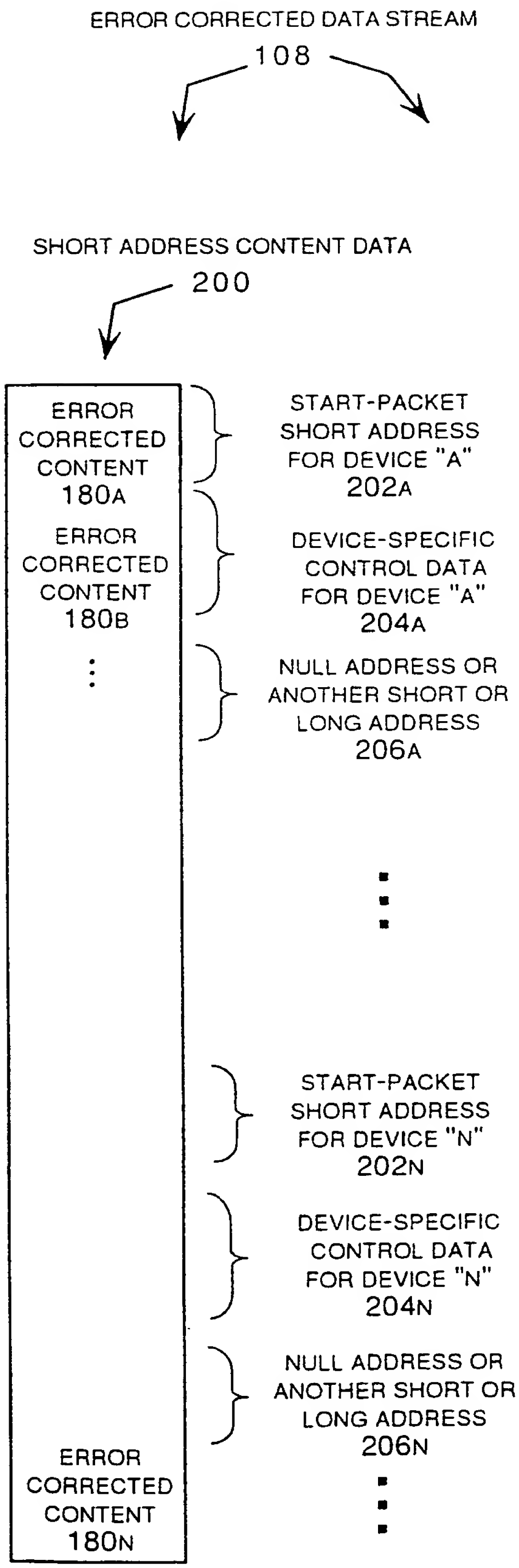


FIG. 12A

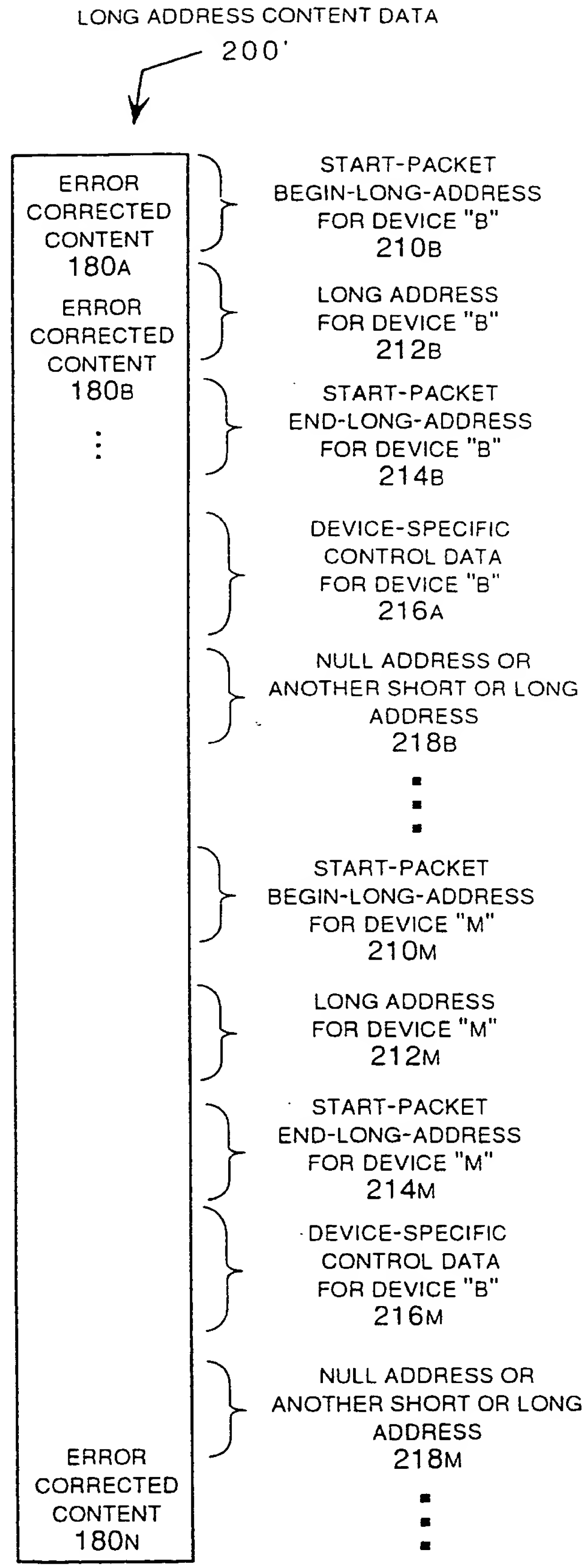


FIG. 12B

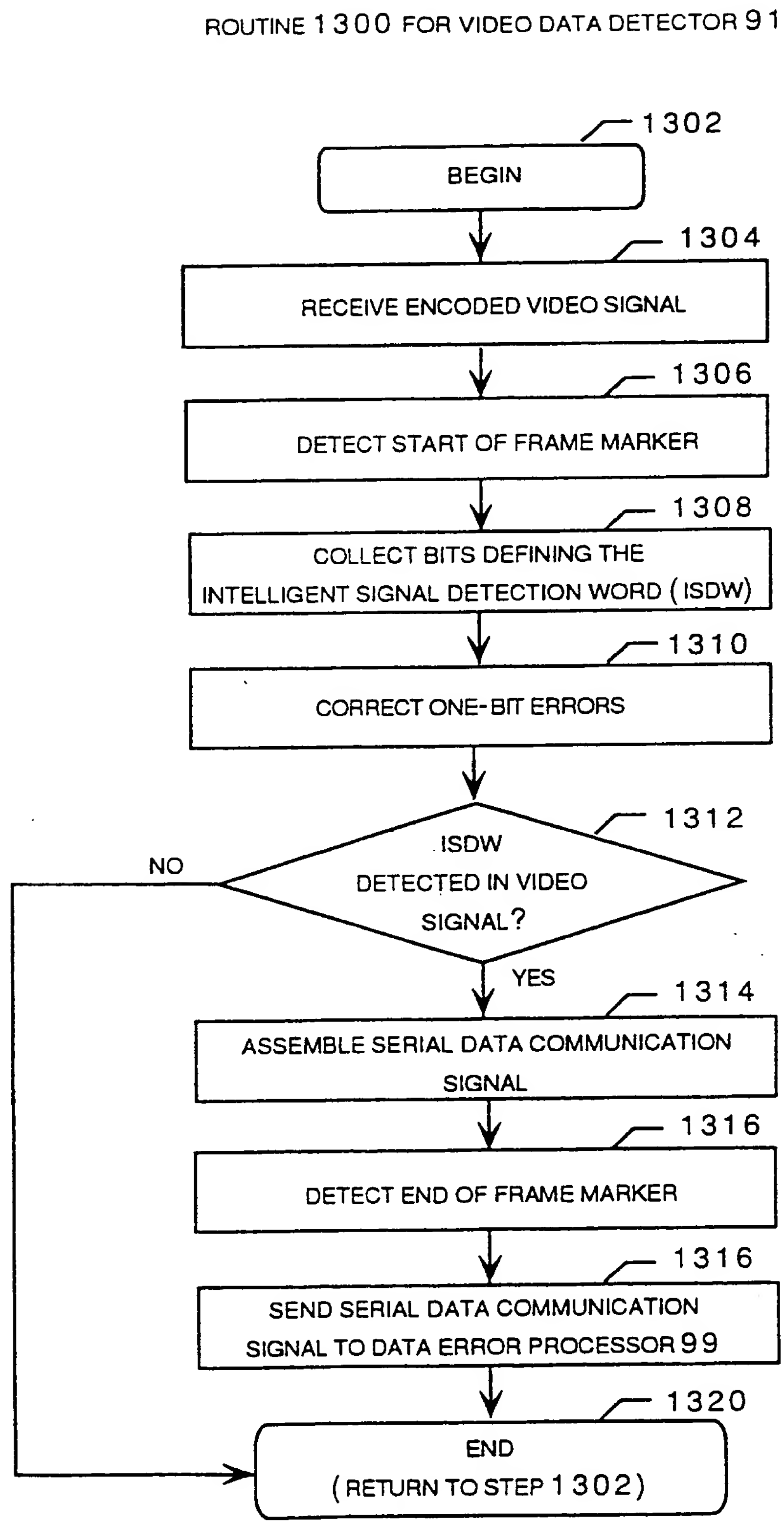

ROUTINE 1300 FOR VIDEO DATA DETECTOR 91
1302
BEGIN
1304
RECEIVE ENCODED VIDEO SIGNAL
1306
DETECT START OF FRAME MARKER
1308
COLLECT BITS DEFINING THE INTELLIGENT SIGNAL DETECTION WORD (ISDW)
1310
CORRECT ONE-BIT ERRORS
1312
ISDW DETECTED IN VIDEO SIGNAL?
NO
YES
1314
ASSEMBLE SERIAL DATA COMMUNICATION SIGNAL
1316
DETECT END OF FRAME MARKER
1316
SEND SERIAL DATA COMMUNICATION SIGNAL TO DATA ERROR PROCESSOR 99
1320
END
(RETURN TO STEP 1302)

FIG. 13

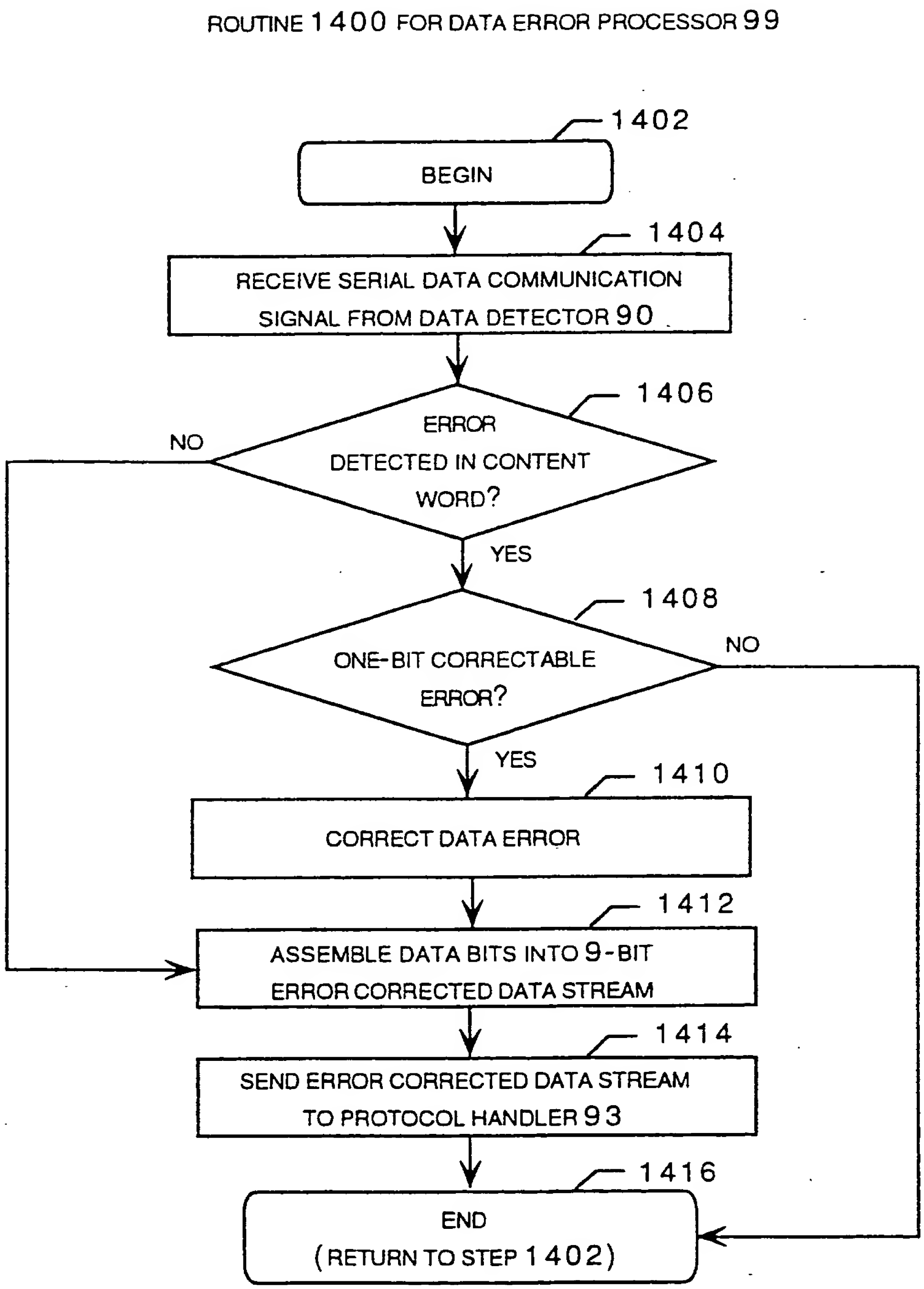

ROUTINE 1400 FOR DATA ERROR PROCESSOR 99
1402
BEGIN
1404
RECEIVE SERIAL DATA COMMUNICATION SIGNAL FROM DATA DETECTOR 90
1406
ERROR DETECTED IN CONTENT WORD?
NO
YES
1408
ONE-BIT CORRECTABLE ERROR?
NO
YES
1410
CORRECT DATA ERROR
1412
ASSEMBLE DATA BITS INTO 9-BIT ERROR CORRECTED DATA STREAM
1414
SEND ERROR CORRECTED DATA STREAM TO PROTOCOL HANDLER 93
1416
END (RETURN TO STEP 1402)

FIG. 14

ROUTINE 1500 FOR THE PROTOCOL HANDLER 93 (SHORT ADDRESS)

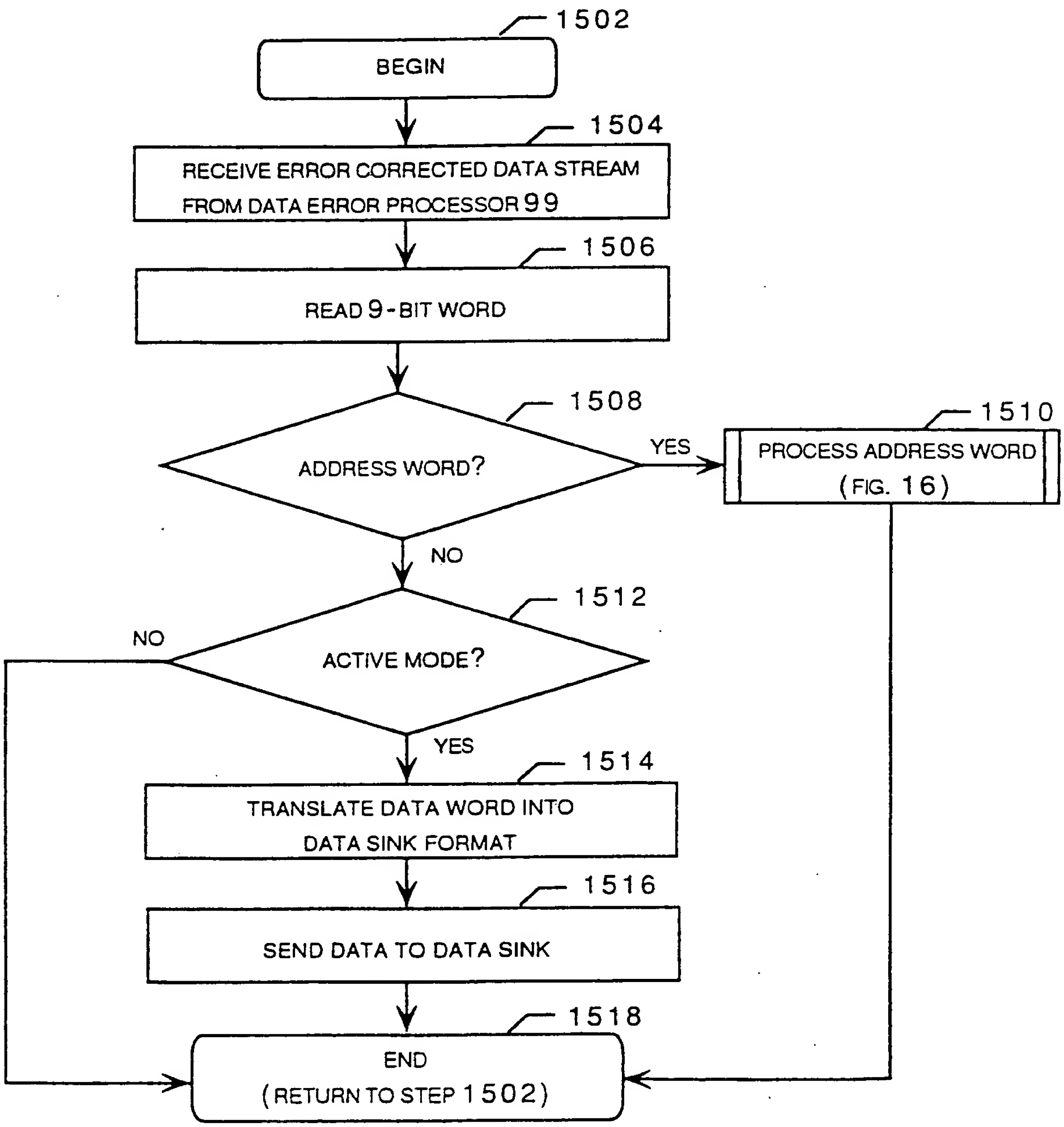


FIG. 15

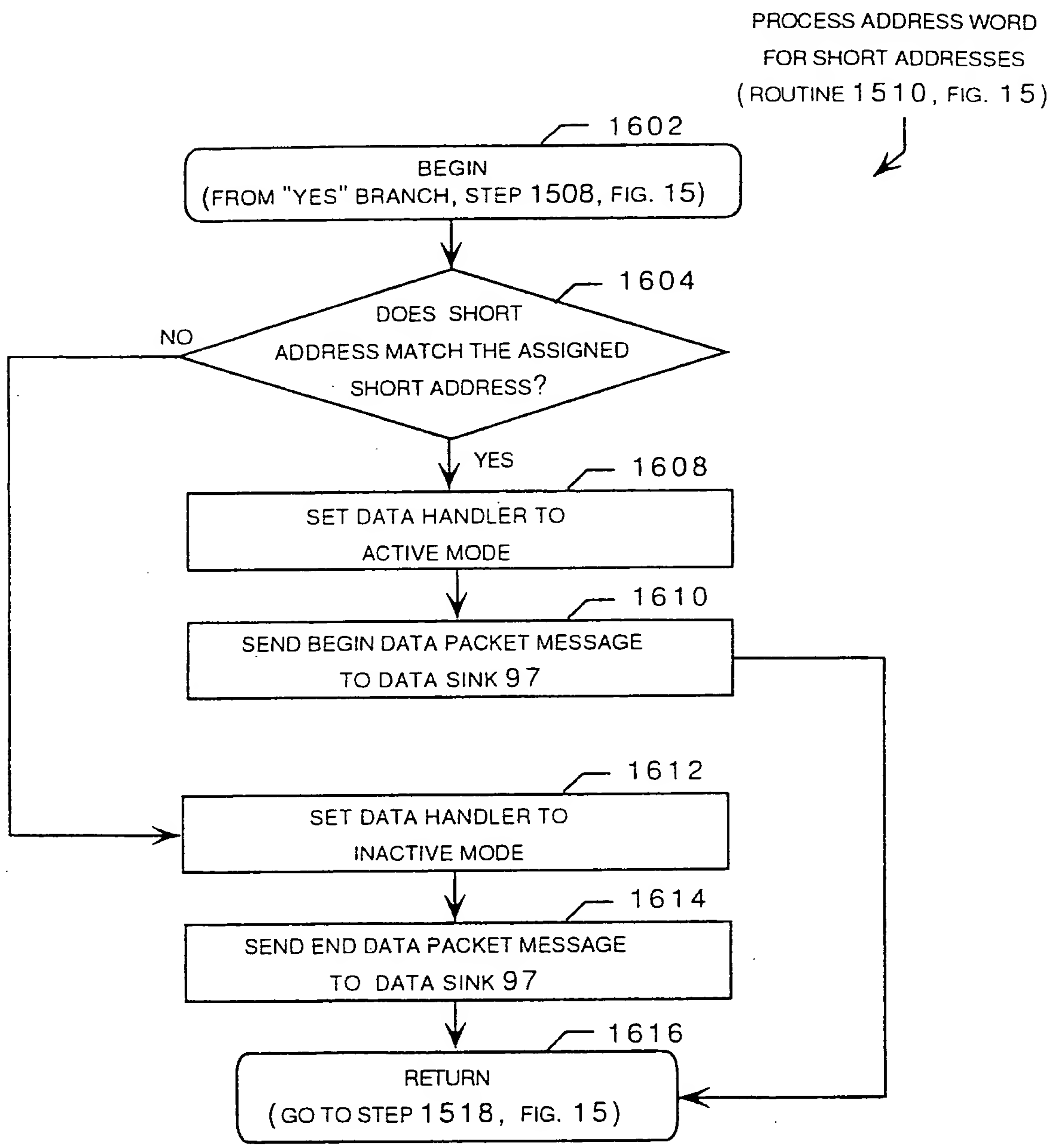

PROCESS ADDRESS WORD
FOR SHORT ADDRESSES
(ROUTINE 1510, FIG. 15)
1602
BEGIN
(FROM "YES" BRANCH, STEP 1508, FIG. 15)
1604
DOES SHORT
ADDRESS MATCH THE ASSIGNED
SHORT ADDRESS?
NO
YES
1608
SET DATA HANDLER TO
ACTIVE MODE
1610
SEND BEGIN DATA PACKET MESSAGE
TO DATA SINK 97
1612
SET DATA HANDLER TO
INACTIVE MODE
1614
SEND END DATA PACKET MESSAGE
TO DATA SINK 97
1616
RETURN
(GO TO STEP 1518, FIG. 15)

FIG. 16

ROUTINE 1700 FOR PROTOCOL HANDLER 93 (LONG ADDRESS)

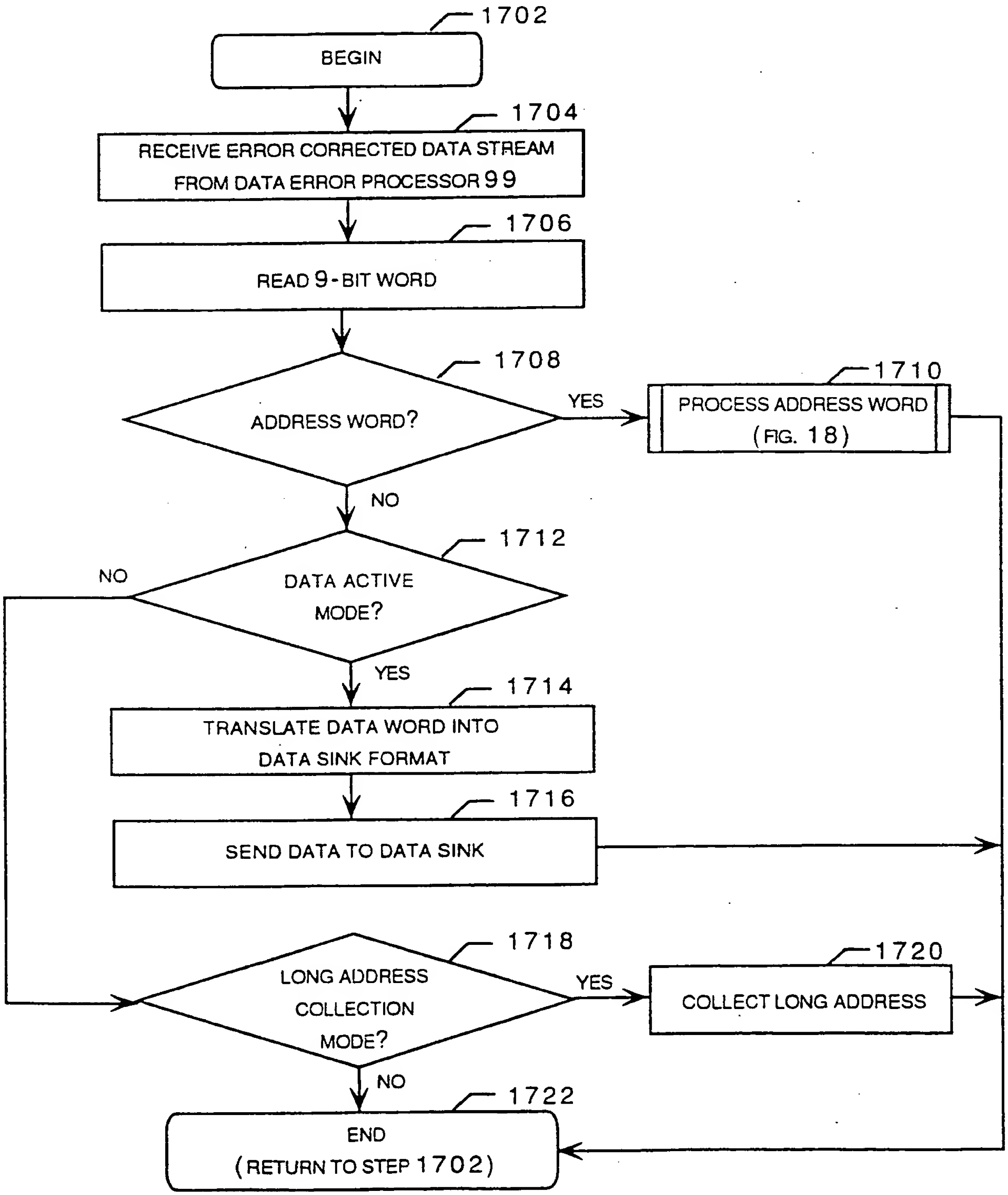


FIG. 17

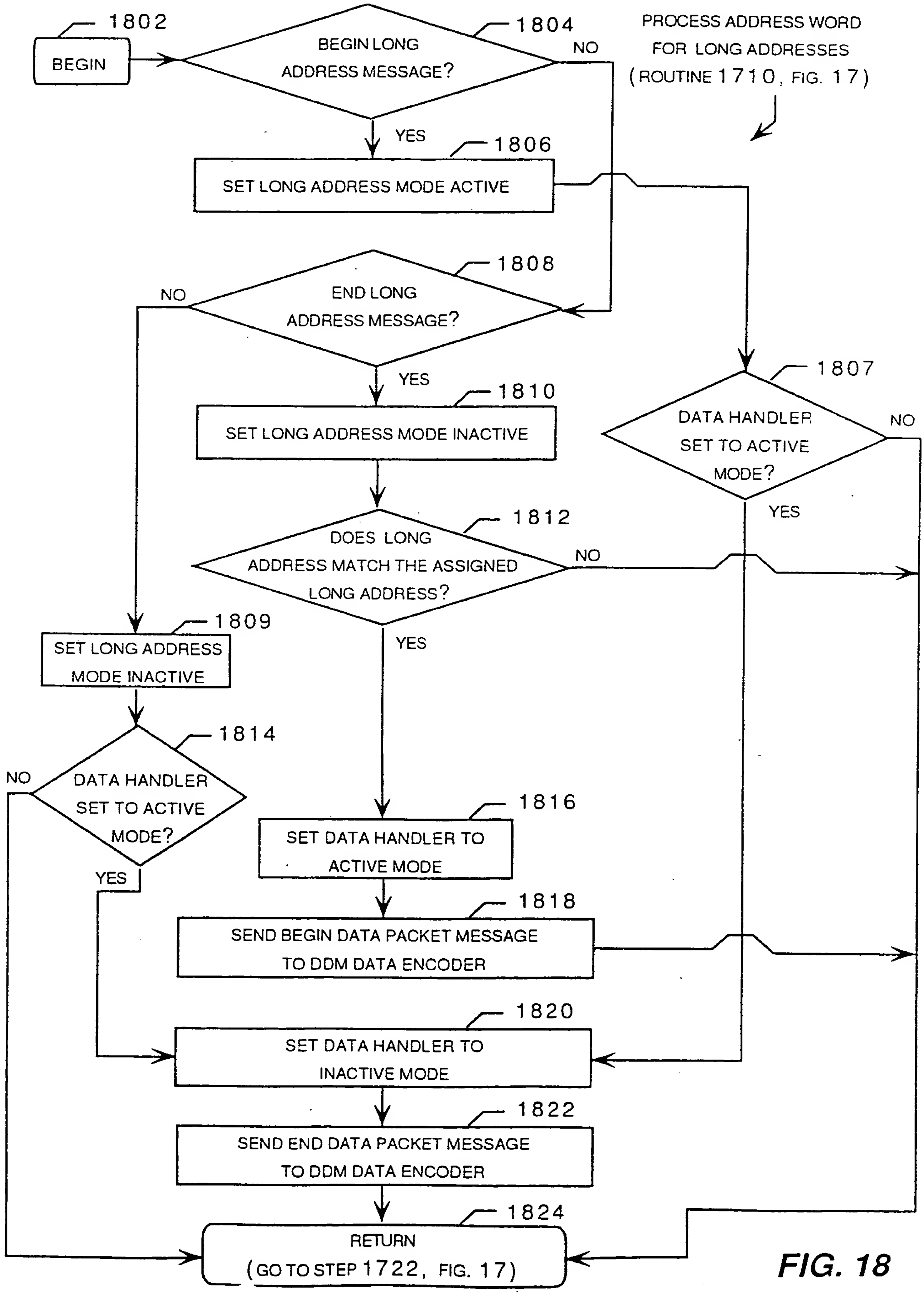

PROCESS ADDRESS WORD FOR LONG ADDRESSES (ROUTINE 1710, FIG. 17)
1802
BEGIN
1804
BEGIN LONG ADDRESS MESSAGE?
NO
YES
1806
SET LONG ADDRESS MODE ACTIVE
1808
END LONG ADDRESS MESSAGE?
NO
YES
1810
SET LONG ADDRESS MODE INACTIVE
1807
DATA HANDLER SET TO ACTIVE MODE?
NO
YES
1812
DOES LONG ADDRESS MATCH THE ASSIGNED LONG ADDRESS?
NO
YES
1809
SET LONG ADDRESS MODE INACTIVE
1814
DATA HANDLER SET TO ACTIVE MODE?
NO
YES
1816
SET DATA HANDLER TO ACTIVE MODE
1818
SEND BEGIN DATA PACKET MESSAGE TO DDM DATA ENCODER
1820
SET DATA HANDLER TO INACTIVE MODE
1822
SEND END DATA PACKET MESSAGE TO DDM DATA ENCODER
1824
RETURN (GO TO STEP 1722, FIG. 17)

FIG. 18

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 98/13482

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N7/08 H04N7/085

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 807 031 A (BROUGHTON ROBERT S ET AL) 21 February 1989 see the whole document	1,2,26, 31 3-25, 27-30, 32-45
A	US 4 771 344 A (TRUCHSESS JOE ET AL) 13 September 1988 see column 3, line 24-41	1-3
A	WO 92 19073 A (NAT BROADCASTING CO) 29 October 1992 see abstract	1
A	EP 0 710 022 A (AT & T CORP) 1 May 1996	
A	US 4 729 563 A (YOKOI GUNPEI) 8 March 1988	

[ ] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 October 1998	15/10/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Poirier, J-M

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/13482

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4807031	A	21-02-1989	AU	615465	B	03-10-1991
			AU	2084288	A	23-05-1989
			CA	1323688	A	26-10-1993
			CN	1036490	A,B	18-10-1989
			DE	3886929	D	17-02-1994
			DE	3886929	T	04-08-1994
			DK	303189	A	20-06-1989
			EP	0346402	A	20-12-1989
			FI	893007	A,B,	19-06-1989
			GR	1000173	B	15-11-1991
			GR	1000595	B	26-08-1992
			HU	209795	B	28-11-1994
			IE	61641	B	16-11-1994
			IL	88089	A	27-02-1994
			IL	107233	A	24-06-1994
			IL	107234	A	31-07-1994
			JP	2545456	B	16-10-1996
			JP	2501881	T	21-06-1990
			KR	9702962	B	13-03-1997
			MX	165159	B	29-10-1992
			NO	176230	B	14-11-1994
			OA	9050	A	31-03-1991
			PT	88800	A,B	31-07-1989
			PT	100213	A	29-04-1994
			RU	2048709	C	20-11-1995
			WO	8904100	A	05-05-1989
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WO 9219073	A	29-10-1992	US	5200822	A	06-04-1993
			AU	663087	B	28-09-1995
			AU	1877092	A	17-11-1992
			CA	2106486	A	24-10-1992
			EP	0581903	A	09-02-1994
			JP	6506809	T	28-07-1994
			MX	9201852	A	01-10-1992
			NZ	242232	A	26-07-1995
EP 0710022	A	01-05-1996	JP	8237622	A	13-09-1996
			US	5663766	A	02-09-1997

INTERNATIONAL SEARCH REPORT

..ormation on patent family members

Intern .al Application No
PCT/US 98/13482

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4729563 A	08-03-1988	JP 1843914 C	12-05-1994
		JP 61156405 A	16-07-1986
		CA 1261471 A	26-09-1989
		US 4815733 A	28-03-1989

Form PCT/ISA/210 (patent family annex) (July 1992)

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